TINKERING
With
TOOLS

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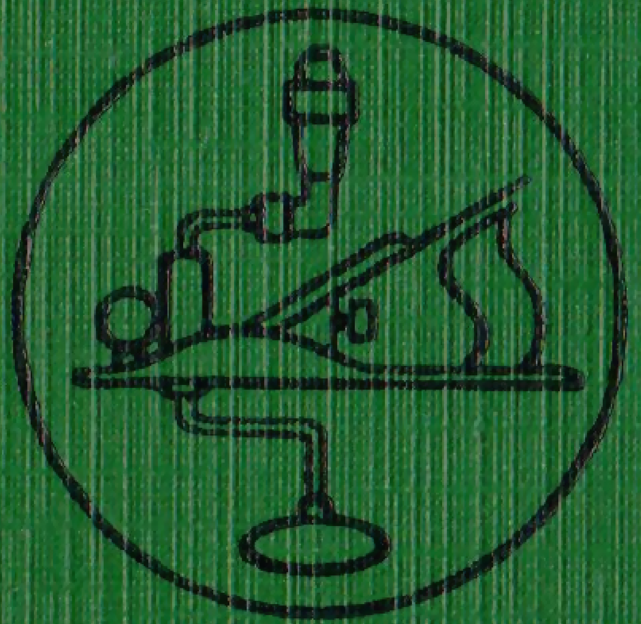
TINKERING *With* TOOLS

NEW, REVISED EDITION



HENRY H. SAYLOR

TINKERING WITH TOOLS

By HENRY H. SAYLOR

Formerly Editor of "Country Life," "The Architectural Review," and "House and Garden." *Author of* "Bungalows," "Making a Fireplace," "The Book of Annuals," Etc.

WITH MANY FULL-PAGE ILLUSTRATIONS AND NUMEROUS DIAGRAMS IN THE TEXT

New Revised Edition

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PRINTED IN THE UNITED STATES OF AMERICA

TO

THE WIFE WHO MARRIED A JACK-OF-ALL-TRADES
AND FOUND HIM MASTER OF NONE

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ILLUSTRATIONS

(Bound in back of book)

FOREWORD TO THE NEW REVISED EDITION

THE aim of this book is not putting more work into life, but more joy into life. If you also find that reading it saves you money, that is a by-product only.

It seems advisable to make clear at the outset the fact that this is not a book telling how to transform some object around the home that is no longer wanted into some other object that has even less excuse for existence. What it does attempt is to bring back to the present day something of the self-reliant craftsmanship of early America, when a man's chief pride and satisfaction lay in his ability to practice any or all of the common crafts. To be ignorant of the use of tools, to be unable to work out for himself the varied problems about his own homestead, was an uncommon, even shameful, thing in those pioneer days.

It is true that in our day the steady increase of specialized knowledge and skills makes unnecessary the highly versatile competence of the pioneer. Nevertheless, we face the emphatic necessity of increasing production, to balance the frantic de-

struction of ever-recurring war, and to provide for higher standards of living. If our civilization is not to slip back, we shall have to do more than balance our losses of material things—we must create more and better things. It is a task that calls for every hand that is capable, and for the schooling of every hand that is not.

This book does not attempt, therefore, a rosy picture of a dream shop, goal of the dilettante, in which he might while away some idle hours. Rather does it aspire to be a practical guide to a working proficiency in some of the things one can and should do for himself in and about the house. But the surprising fact, to those who are just entering their novitiate in these everyday crafts, is that what might seem like mere drudgery so often turns out to be keenly enjoyable for its own sake.

To know the joy of edged tools, to be able to set one's hand confidently to a manual task and leave it well done, to experience the quiet triumph of skilled craftsmanship—these things offer a rock of refuge in our present whirlpool of manual incapacity. If this book can point the way to that refuge, it will have achieved a worthy purpose.

NEW REVISED EDITION

TINKERING WITH TOOLS

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CHAPTER I

Do It Yourself

The age of specialization in which we live is certainly not one of unmixed blessings. Invention undoubtedly is pushed forward to greater achievements in these days when the inventor can be relieved of the necessity for doing everything that does not lie in the particular trail he is blazing. And of course the products of his inventive genius become in time the property of us all, to lighten our burdens and give us unaccustomed comforts. Nevertheless, the system unquestionably lowers the average man's ability to do things for himself.

A friend of mine recently went to England to live. His household was a rather elaborate ménage, with two or three times the number of servants that he had considered necessary in this country. The complex English system annoyed

and astonished him, particularly in the extent to which specialization had been carried. For instance, one wanted a fire laid on the drawing-room hearth. One summoned the butler and ordered a fire. The butler in turn instructed the first footman, who passed the word along to the second houseman, and so on. At the lower end of this line the instructions finally reached a servant who answered to the title of "the odd boy." The boy happened to be some sixty years old, but his title was none the less youthful for all that. He it was who laid the papers, kindling, and logs in the strictly traditional manner and reported to his superior. The word traveled back up the line and finally prompted the butler himself to touch a match to the pile and thus complete the task.

If one wanted a picture hung, however, the process became considerably more involved. The instructions started as before, but in this case neither "the odd boy" nor any one else on the way down to him considered the matter within his own jurisdiction. Neither could any of the female line, from housekeeper down to scullery maid, be drafted for this specialized work. In England, a house servant is a butler or a first doorman or a chambermaid or whatnot, with certain prescribed duties, among which is not included the hanging of a picture. A carpenter must be fetched for that task.

Civilized Incompetence. All of which is amusing and absurd; yet we ourselves are coming very close to such helplessness. Were one of our early American pioneers permitted to come back and see the evidences of our incompetence that must necessarily thrust themselves upon his attention, his scornful pity would not be a comforting sight. He who in the day's work might easily be called upon to be carpenter, harness maker, hydraulic engineer, veterinarian, locksmith, farmer, trapper, blacksmith, mason, cook, machinist, would certainly think that civilization had brought the American city man of to-day to a sorry pass.

The delicatessen store on a near-by corner has made subsistence too much a matter of course with us. The telephone and the concentration of population in the cities have become a combination in restraint of self-reliance. Necessity no longer drives, so our native ability to do things for ourselves has become atrophied.

Pioneer Problems. Think of the problems that confronted the pioneer as winter loomed up ahead of him (or in only slightly less degree, that must be solved by the isolated farmer to-day). Food supply was one. It is not surprising that we recall with wonder the great stocks of flour, sugar, coffee, and tea that were husbanded; the cool cellars crowded with vegetables and fruit, packed to keep in a way that has become to us a lost art. The hams and sides of bacon that the

smokehouse cured; the preserve closets that ranged row on row; the woodpile stacked high under the shed roof with neatly sawn and split fuel; the barn lofts bursting with hay and straw; the feed bins heaping full of grain; the medicine chest stocked with a winter's needs in medicines and herbs; the storerooms filled with woolens and linens — all these had to be put between the pioneer's family and a threatened extinction before he could call his fall work done.

It is small comfort to consider that we no longer face these problems merely because we have put ourselves above them with our modern methods of specialization and distribution. We have gained in convenience, in comfort; we have lost heavily in self-reliance, in well-rounded manhood.

Developing One's Latent Ability. I believe and hope that the pendulum has nearly reached the end of its arc, and that it is about to swing back. Specialization may contain its own cure. The man who spends his eight-hour day in the screwing of a standardized nut on a standardized automobile axle, with the least loss of motion and effort and a corresponding speed and earning power, may come in time to resent the fact that he has to pay a plasterer twenty dollars a day to finish his house. He may awake to the fact that he has some slight vestige of ability left him to do some things for himself.

If such a thing does come to pass, the economic

gain to the nation will be stupendous. Our friend the automobile assembler cannot be expected to put in much more than his eight hours in twirling standardized nuts — if he is to retain his reason. He can, however, spend another two or three hours on an entirely different task, and get some fun out of it, too, if he is working solely for his own benefit and at his own pleasure. The addition of twenty-five per cent. to the productive time of a large part of this great people, without the corresponding grind of real clock-punching necessity, but rather with the invigorating satisfaction of a developing craftsmanship, would roll this old world a lot nearer the millennium.

Nevertheless, it is not in the fond thought of such accomplishment that this book has been written. It makes no pretense to any such economic propaganda. Its aim is not so much putting more work into life as putting more joy into life. If it should be found showing you how to save money, that is a mere by-product. If it should show you a new way to get more fun out of life, a way that incidentally leads to a more fully rounded knowledge of various homely crafts; to the unequaled satisfaction of doing things and finding them well done; to a greater confidence in your own ability to conquer inanimate things — if it should bring you a little closer to the sort of self-reliance upon which America was built, the book will have achieved the height of its purpose.

CHAPTER II

THE JOY OF EDGED TOOLS

IN Hugh Black's essay on "Work" (1902), it was a disappointment to me to find him contrasting work and rest. Perhaps it is merely a difference between definitions — in the meaning we ascribe to the word "work." If we think of work as a grind, a disagreeable necessity, something to be brought to an end as quickly as possible in order that we may rest, then the contrast is justified.

The Benefits of a Work Hobby. On the other hand, a change in occupation is rest, though after the change we may still be accomplishing work. To my mind this change in occupation, if it be a pleasurable one, is, indeed, the very highest form of rest. For most men, perhaps, the most pleasurable change in occupation is from business to golf, the dropping of work with the hands or brain and the shift of one's energies to pure play. There can be no quarrel with this choice, or with that of the man to whom an hour in the saddle or on the tennis court brings real rest in physical

exercise. It is entirely a matter of personal taste. Yet I cannot but feel that he whose rest is found in a change of occupation that leads to other work, rather than merely from work to play, tastes the greater joy. He who finds recreation of his body in mere sport gains but that one by-product of his enjoyment. He who by preference finds recreation of his body in work loses nothing in enjoyment and has the additional reward of material accomplishment. The fruits of eighteen holes of golf are pleasantly tired muscles and a relief from care. The fruits of an equal time spent in some branch of craftsmanship are pleasantly tired muscles, an equal relief from care, and a more or less gratifying product of the work of one's hands.

Incidentally, the shift from business to a work hobby can be made for even a few otherwise wasted minutes or for a few hours in the evening, whereas the shift from business to outdoor play is seldom practicable except on the traditional Saturday afternoon. It is an accepted fact that short and frequent periods of rest are far more beneficial than are longer periods of rest at greater intervals. A yearly or even a weekly vacation period cannot take the place of daily rest.

In this argument for the beneficial and enjoyable rest of a work hobby, it should be clear that not every hobby meets *all* the needs. Reading, or research, or art might serve equally well to

give the change of occupation that is rest, and moreover would bring the by-product of tangible results; yet none of these brings the essential of physical work, upon which a large part of the benefits of craftsmanship depends. Nor does such a hobby always permit the full shift of both mind and body to exercise in entirely new channels.

In these days, when nervous breakdowns are coming to be nearly as common an affliction of middle age as measles are of childhood, it behooves us to look more closely to our mode of life. Unceasing application to a vocation may be productive of specialized knowledge to a degree that former generations have not touched; but it is a consuming flame, a flame that requires the very life of those who cannot or will not break away from its tyranny. And, after all, it is at least a debatable question whether unceasing effort is as efficacious in the long run as is repeated effort stimulated by periods of relaxation.

In spite, however, of the strong temptation to make this chapter a bit of special pleading, its purpose lies in another direction. It surely would benefit neither the reader nor myself if I could persuade him to do a little new and interesting work for his stomach's sake. I might preach an eloquent sermon, had I the ability, on the theme "Two jobs a day keep the doctor away"; but the results would be disappointing. The effort would be comparable to urging a man to learn

to play the piano for the sake of the exercise he would give his fingers. Only sheer will-power could hold him to such a task in the absence of a real joy in the music produced. Likewise, nothing short of a miracle could produce any real good by persuading a man to take up a work hobby merely as a form of exercise or for the benefit of his nervous system. If he is so constituted as to be able to get real joy and healthful exercise out of working at odd moments with his hands and in a different and lighter way with his brain at the same time, we shall gladly welcome him to the ancient and honorable Guild of Amateur Craftsmen. If such work has no such appeal to him, we shall bid him Godspeed to the golf course; and may he achieve par.

A Specimen Job, and How to Do It. Come with me into the workshop, if you will, and let me show you how we of the Guild find joy in the work of our hands.

There are always three or four pieces of work in process, not only for the sake of a variety of operations that offer satisfaction to one's particular mood or fit the available time to spare, but also because they dovetail together in many ways. Here, for example, is some wood joinery glued up and cramped while drying. Here is a little antique bureau stand, minus its mirror posts and badly damaged on the top surface; it is awaiting further operations until we have made a trip to

the city and obtained a suitable sheet of mahogany veneer. In that corner are half a dozen frames for screens, their priming coat of paint almost dry. On that shelf is a miscellaneous assortment of eighteenth-century hardware, rescued from a house that was being demolished; some day we must take it to pieces, replace missing parts, make keys to fit, and put it into service again. An old mahogany mirror that has been outraged by successive coats of paint is awaiting the mood when scraping will appeal to us, preparatory to the careful refinishing its hidden beauty deserves.

Suppose we select this broken mahogany desk. It occupies a lot of shop space that could be used to advantage in many ways. It is a fine old piece, the work of some unknown cabinetmaker of the early nineteenth century. The sloping lid is off its hinges, one sliding arm is gone entirely, the back is missing, and, worst of all, the top has been broken away from its beautifully secret-dovetailed joints with the ends and has been replaced by a pine board, nailed on. It is not to be wondered at that the desk's previous owner had relegated it to the barnyard.

First, let us take off that makeshift top, drawing the nails carefully to prevent splitting the desk ends. Notice the exquisite joinery that originally connected the top and ends — a mitered corner to prevent the end grain of both pieces from showing, with dovetailing beneath it. That is

going to be a task worthy of our utmost skill, the duplication of that top joint on both ends of a three-quarter-inch mahogany board. We shall not be able to get as good a piece as this from new wood, but by careful staining we shall approximate a match. The old glue must be very carefully cut away from the faces of the dovetailing with a sharp chisel. The worn screw holes for the lid hinges will have to be plugged. A new back is the easiest of all — merely thin, soft pine, lap-jointed horizontally and slipped up from the bottom into the rebates in the back edges of the ends.

Fine Points of Doweling. Here is a waste piece of mahogany that will serve for the missing arm. We rip it to the proper width, cut it short enough to take an end-facing piece, and plane it down. The thin mahogany shavings curl up through the plane. Do you smell that delicate aroma of freshly surfaced wood — essential oils stored away among the fibers in the damp heat of a South American forest? We plane the strip for the end facing. It might be merely glued to the trued end grain of our main sliding arm, but doweling will make a real workmanlike job of it. Two holes are bored in the end of the arm with a five-sixteenths auger bit, set to stop at an inch depth. They will just take this hard-maple doweling that we buy in long pieces and cut off as we need it. It demands a nice precision

to get our corresponding holes in the facing strip, so that the latter will be exactly flush on both sides. We bore these holes only three eighths deep, as the facing is too thin to take a longer dowel. Here is where our bit stop is well nigh indispensable, and we shall use a Forstner bit to get a flat-bottomed hole. With the doweling in place but not yet glued, we find we need to scrape a hair's breadth off one side of the front strip to get a perfectly flush joint, and sandpaper down the ends of the facing strip.

Another hole in the side of the arm near the back end, with a hardwood plug to prevent its coming all the way out of the slide, and we are ready for gluing. The facing strip's holes are glued, as are the dowels and the corresponding holes in the arm, and the joint is closed and cramped against a bench stop with the vise. And now dinner must be ready, for we've been working for two hours. Is it less interesting than golf or tennis?

CHAPTER III

The Home Workshop

It would be an interesting exercise for me to set down the various elements of the ideal workshop; showing by careful reasoning just where it should be located, how the windows had best be arranged, the necessity for good ventilation and dry air for the prevention of rust on the tools, and so on. I am afraid, however, that it would be little more than an exercise in writing, dealing with a world of beautiful theory rather than with the unyielding facts that face the great majority of us.

Location and General Fitness. Unfortunately, the location and character of the home workshop are not determined by any such exercise of choice as I might assume for the above hypothesis. We have a workshop — or we have not.

If, in an unforeseen remnant of space not otherwise employed by an architect who unquestionably tried hard to utilize it, a workshop is left for us, we accept it thankfully and raise no further issue as to its size, location, ventilation, or general

fitness for the use to which a kind Providence has relegated it. Indeed, we shall do well to put it to immediate use and establish its character once and for all time, for there is no telling when a new need may rise to claim it if we do not.

I think I have had workshops in all the commonly accepted locations: cellar, attic, stable loft, garage. Undoubtedly some were better than others, yet it is not readily recalled to mind just which they were. Each seems, in retrospect, to have served its purpose fairly satisfactorily. Like virtue, taking things as one finds them is its own reward.

For those who are less supine, it might be well to suggest that attics are usually cold in winter and hot in summer; that cellars are usually too dark, and frequently too damp for good tools; and that detached buildings bring difficulties of heating for winter work. Most of the objectionable features of these kinds can be overcome, however, with a little ingenuity — and ingenuity is almost the one thing that the home craftsman should have "nothing else but."

The lone tool chest, or its modern adaptation, the neatly equipped wall cabinet, may have to serve the flat-dweller in lieu of a workshop, but it is a feeble substitute at best. Even as a place to keep tools, it occupies much the same station as the place designated for the storage of the

children's overshoes — usually the one place in the house where it would be folly to seek them.

A workshop in its essentials comprises a workbench, tools within easy reach, and space for supplies — nails, screws, paint, wood, and such things.

The Amateur's Workbench and Its Equipment. I would give the bench first place. It is as much the center and soul of the workshop as the hearth is of the home. Everything revolves about it. Working without a bench is like working with one arm in a sling; it can be done, but it is scarcely worth the effort. Start your equipment with a well-made, sturdy workbench, not necessarily large, but thoroughly equipped with two vises, planing stops, and a maple top. The type of bench that is made in quantities for the use of manual-training classes will serve every purpose; it is built for work, not merely for appearances. My envy is all too frequently aroused by those marvelously equipped cabinet benches that the hardware store displays as its center of interest in a holiday window. Folding doors are thrown back, bristling with tools of every conceivable kind; the top lid is raised to display supplementary racks of more tools; drawers and cupboards hold neat arrays of supplies. The possession of such an arsenal must be an inspiration sufficient to keep the home craftsman away from meals, sleep, and family life, while he creates master-

pieces in wood. Strangely enough, I have never known a man who possessed one. Perhaps the man does not live who dares buy one and face the responsibility it seems to entail. He would be left absolutely without an alibi for the neglect of anything that henceforth needed attention in the household. The cabinet workbench is a blood brother of the plaid golf bag; there is no inherent reason why its owner should not do great things with the contents, yet he rarely does.

It is safer on the whole to affect a certain humility of spirit in one's workbench. The sort of bench that really humbles the amateur craftsman is the scarred veteran you will come upon in some old-school carpenter's shop. Before such a shrine, eloquent of faithful, long service, one may well remove his hat in reverent admiration. Here worked a master craftsman.

For several years I have been meaning to buy a really good bench for myself. The one that serves me is a poor thing — a pair of nine-inch cypress planks battened together underneath and resting in a standard roughly assembled of three-by-fours and six-inch ledge boards. A vise screw and its sockets, fastened to ledge and to another upright plank, provide a wooden vise at the left front. A quick-acting iron vise is set on the right-hand end. A planing stop is countersunk at the left in the top. In the front top ledge is fitted a drawer for nails, made of a sawed-off case for ginger-ale bottles. The square compartments are of a convenient size to hold packages of brads, tacks, glazing points, or whatnot. It is a disreputable bench, its wooden vise none too secure; but there is the great advantage that one does not fear to damage its rough, discolored top as one might a brand-new, smooth, maple one. I think it would long ago have given place to a real bench if it were not so much like a well-broken briar pipe or a pair of comfortable old boots.

Set the bench directly in front of a window. Light over the left shoulder may be the ideal arrangement for a desk, but it is not good enough for the workbench. All that is to be had is none too much; and if this comes directly from in front of the bench and slightly above it, as you stand before it, there will be the least chance of working in your own shadow. The source of artificial light should naturally be similarly located.

The size of the shop is a matter that need not give so much concern. You will undoubtedly be grateful for all the space you can get, but limitations of area are not serious. Five by eight feet, perhaps, would be a minimum, inconvenient only when long pieces are being worked; and these can be taken outside. A greater area gives storage space overhead for molding strips and similar material, which will have to be kept elsewhere when the shop's area must be small. Al-

most indispensable, when large work has to be taken outside, are wooden horses upon which to rest work that is in progress.

The Handy Arrangement of Tools. With the workbench in place, and particular care being given to its rigidity, the next consideration is the ready availability of tools and supplies. In the old-fashioned carpenter shop (you may be fortunate enough to find one to inspire you), a wooden ledge, above and behind the bench, was usually notched and perforated in various shapes to hold the smaller tools — chisels, bits, hammers, etc. A broader shelf probably held the planes — always laid on their sides to protect the cutting bits, while the saws hung from beneath the end of the bench top. Modern ingenuity has added but one marked improvement on this equipment, and that is found in the strips of brass that are punched and bent to form continuous racks for tools with such handles as the chisels and files. A few screws will fasten to the wall, or to a board above and back of the bench, such a strip of a length to fit individual requirements. Upon the same vertical surface it is a simple matter to insert L-shaped brass screws in pairs to support hammers, brace, try-square, etc. The saws will need another place; their greater length will not permit their easy withdrawal from behind the bench, so it is usually convenient to hang them from the same sort of L-shaped screws just beneath the

bench top at the right-hand end. A shelf six or eight inches wide, placed above the tool racks, will provide a resting place for the planes, level, and other tools that are not readily hung. In this way, an astonishingly large number of tools can be in sight and placed within easy reach; and the advantage of having them thus instantly available, rather than in chests or drawers or cupboards, is easily appreciated.

Thus far the discussion of the workshop's character and contents may have created the impression that the shop is designed solely for carpenter work. If so, this is by no means the author's intention. The carpentry end of home craftsmanship is probably the most important part, not only in the finished product, but in the bulk of equipment and supplies. Nevertheless it is not only feasible but distinctly more convenient to bring together in this one industrial center practically all the tools and most of the minor supplies that will be used in the amateur's work, not only as carpenter but also as electrician, painter, plumber, mason, and plasterer. The tools will logically be arranged with an eye to their use in groups, but the groups overlap to some extent — the hammer, screwdriver, pliers, awl, file, etc., being called into action under more than one banner. In the same way, it is a great convenience to group with the nails and screws in similar accessibility the shade brackets,

hose washers, wire, odd keys, or whatnot, sometime to be wanted and otherwise rarely to be found.

There are two possible objections to the "tools in sight" scheme. One is that, being exposed fully to the air, the tools are more likely to rust. The objection is not a serious one; tools will rust if they are not well cared for, whether they hang on a wall or repose in a chest. The chest may postpone the event a bit longer, but will not prevent it. However, the ounce of prevention for this greatest enemy of all tools is a very simple thing, which will be discussed in its proper place, the next chapter.

A Scheme of Protection against Borrowers. The second objection to having one's tools displayed is that borrowing is made perilously easy. Any one whose quarter-inch chisel has been drafted by the children to do duty as a screwdriver, will appreciate the force of this objection. It would seem, on the face of it, the part of prudence to keep edged tools under lock and key. Locking the shop suggests itself as an easy way out of the danger, but in most cases this seems not to be feasible. Then, too, locked treasures appear to have all the more attraction for those beyond the barricade. There is another way, and curiously enough it seems to depend upon psychology alone for its efficacy. I am not going to attempt an explanation of why it works;

you may form your own theory as to that, or you may take the scheme on faith. It really works — that is the main thing.

Like many other principles of far greater importance, this automatic protection of tools disclosed itself as a by-product of an entirely different purpose. Since it is evident that having all tools immediately within reach is a great time-saver, it is also evident that an equal facility is desirable in getting the tools back into their respective niches after use. Laying them upon an uncovered spot of the bench will not do. The accumulation is soon great enough to cause a stoppage of the work until the bench is cleared. The seizing of a tool from its place on the wall is easy enough, because the tool is there to be seen. Putting it back is not quite so easy, because of the mental effort required to remember where it goes. To overcome this obstacle, slight as it is, a silhouette of each tool was painted in its proper location on the wall. The necessity for thought was cut out at once. Each tool, after use, goes back almost automatically to the place designed to hold it. The eye takes it there, rather than the brain.

There is another incidental advantage in the scheme: a missing tool betrays its absence at a glance. One does not have to ask himself whether this particular rack was fully utilized or not; whether this particular vacant hook held a dust-

brush or a bevel. Each uncovered silhouette calls out, "Here belongs the small hammer! Here belongs the brace!"

Perhaps this is why the tools are more likely to stay where they belong than to be brought into the kitchen to open a can of salmon or pry up a tacked carpet. The would-be borrower sees that every tool has a place, and that place is unmistakable. A tool borrowed from a chest will scarcely be missed; one borrowed from that painted wall leaves an accusing silhouette to tell the tale. Or it may be that such an evident sense of orderliness and system seems too righteous readily to be violated. Explain it as you will, the tools stay where they belong, or, if borrowed for their proper use, are promptly returned.

The Storage of Supplies. The problem of keeping supplies as conveniently at hand is not so easily solved. A drawer or two in the work-bench, divided into regular compartments, will furnish space for practically all the tacks, brads, and flathead and finishing nails that will ordinarily be used. Similar drawers will be needed for flathead screws and roundhead screws. I find it practically necessary to keep twelve sizes of each in stock. Then there are scores of other items that can be conveniently stored in other drawers or trays of the same character: glazing points, picture hooks, washers of steel and rubber, square and hexagonal nuts, machine screws and

bolts, brass hooks, expansion screw sockets for fastening things to plastered walls — the list could be carried on almost indefinitely. Needless to say, one would never think of stocking up all such things in establishing the workshop. A need arises now for one thing, now for another, and in the long run it is usually just as cheap to buy a small quantity of each needed item, rather than the two or three that may be required at the moment. Gradually the reserve stock grows, increased frequently by discarded odds and ends that have been superseded or partially replaced, until the necessity for trips to the hardware store becomes less and less frequent.

It is rather common practice in most households to dump all these odds and ends, if they are saved at all, into a box of miscellaneous junk from which one never draws them out again for use. Usually the chance of finding what is needed is too remote to warrant the search. It does take a bit more storage space to keep these things sorted, but I think it will be found well worth the effort, especially after the discovery that, when a job of repairing is to be done, time-consuming visits to the hardware dealers are thus made the exception rather than the rule.

The storage of wood, on the other hand, does not work out to such good effect. It is well to keep a pile of odd boards, moldings, and similar material in a dry place, if such is available; but

the chances of finding at hand what is needed are decidedly less than in the case of hardware supplies. A supply that would be adequate and varied enough for most needs would require more space than is usually available. Then, too, it cannot so easily be kept in an orderly manner and

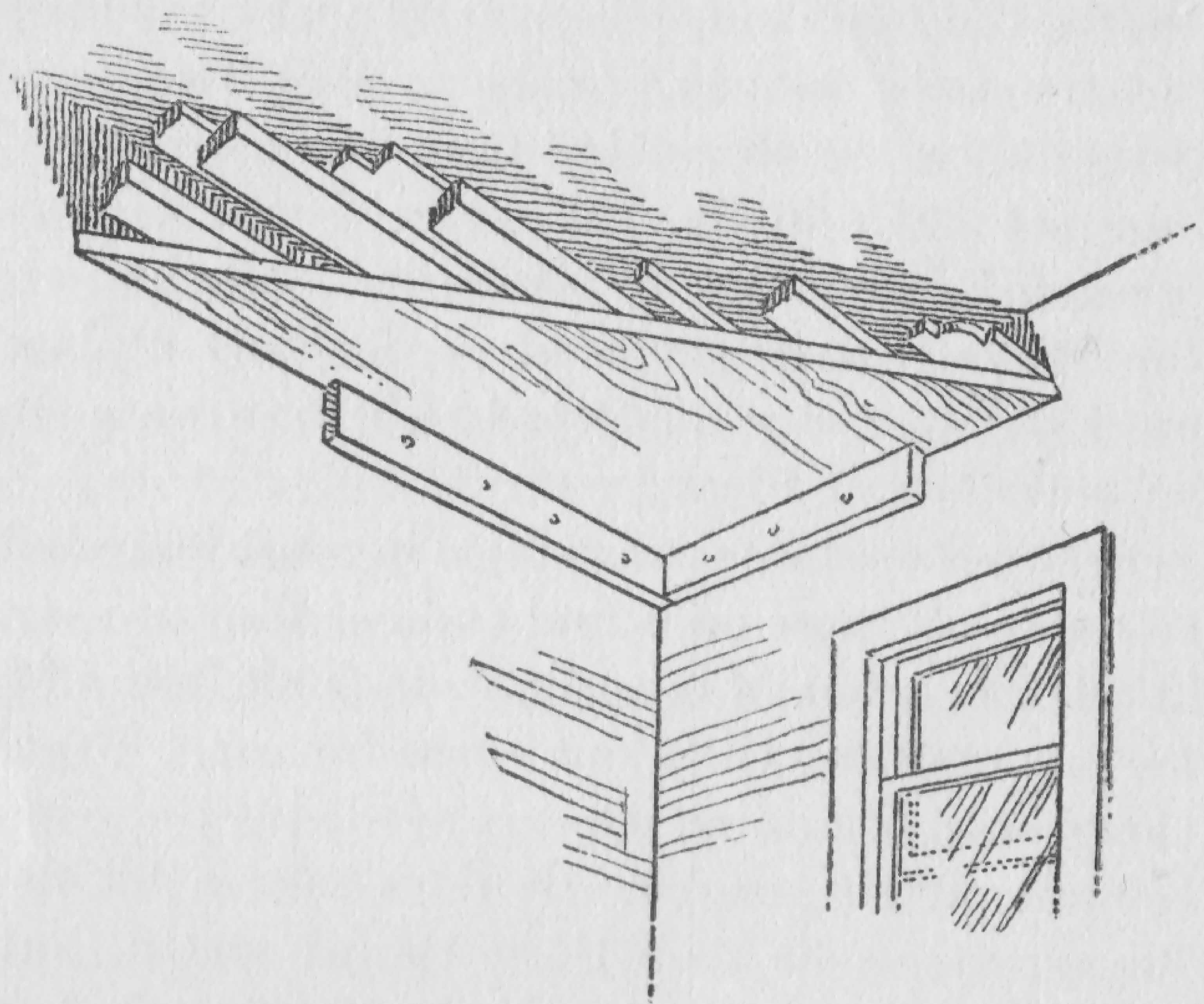

FIG. 1: The triangular form of overhead storage for odds and ends of wood prevents the short pieces from being lost in the pile.

ready for use. The more practicable course, I believe, in the case of work requiring lumber, is to plan far enough ahead to be able to order from the mill what is needed and have it delivered ready for use. Left-over pieces are easily retrieved if kept on a shelf overhead and arranged according to their length; and if the shelf is trian-

gular in plan (as in Figure 1), they will be readily visible from below.

The Place of the Planing Mill. The joy of working in wood becomes rather strained when one has to rip a twelve-inch board into two six-inch ones, or saw a long, thin strip off a piece of rough lumber and plane it to the required finish. Life seems rather long at times, but scarcely long enough to warrant doing extensive work that is done far better, cheaper, and more quickly by planing-mill machinery. Any one who has taken an order for sized lumber to his near-by mill and watched it pushed easily and quickly through saw and planer to meet his special needs, will be pretty thoroughly cured of the habit of attempting such work by hand.

I would by no means disparage work for work's sake, but there is a certain lack of spice in sawing a board merely for the sake of the sweat that it entails. There is far more likelihood of a repetition of the effort, with no loss of joy in the doing of it, if concrete results are more quickly achieved. And these are more likely to be completed within our own lifetime if we forego the doubtful pleasure of cutting down a tree, ripping it into lumber, and seasoning it, before we get around to making our screen door or cupboard, or whatever may be our ultimate objective.

Keeping Things Tidy. A small barrel, a keg, a chip basket, or a box of equivalent capacity

will be found essential as a receptacle for scraps. This can go under the bench if there is room, or elsewhere near. The ordinary dustbrush should have its proper hook among the tools on the wall, and it will be found by no means the least useful of all that array. A sweep or two across the bench top will clear it of chips, shavings, sawn ends, and anything else that may be impeding the work. And if the habit has been formed of putting tools back in their places when they have served the immediate purpose, that quick sweep of the brush will not have to be stayed by the possibility of including tools in the waste. Incidentally, it is hardly worth while to attempt the sweeping of these impedimenta directly into the scrap barrel. There will be at best so generous a contribution of shavings and sawdust on the floor that it will be easier to make one job of the cleaning at the end, preferably with the aid of a dustpan.

The stage being set, scenery and properties in place, we have next to face the task of selecting, for the many and varied rôles to be played, the cast — to which may well be given a chapter of its own.

CHAPTER IV

The Selection of Tools

Given a hammer, a saw, and a square, a man can build a house. On the other hand, a man may possess the most elaborate set of tools that is obtainable as a unit, with workbench cabinet and all the trimmings, costing about $250, yet have not the means of making the simplest turned chair spindle. There is no such thing as "a complete set of tools" — outside of the tool supply house. It is of little use to buy a so-called "set", proportionate in number and variety to the amount of money one can afford to spend, neatly arranged in a chest or a wall cabinet. That is not the way to equip the shop of the home craftsman.

A tool may be regarded as an extension of the hand. With it, the hand is able to accomplish something that without the tool would be difficult or impossible. Brace and bit confer upon the hand the power to bore a clean hole through wood; a soldering iron enables the hand to join together certain metallic surfaces. The choice and pur-

chase of tools, then, depends entirely upon what the hand must accomplish. The craftsman who would build a radio set will need certain tools; he who would build a mahogany-veneered desk will need widely different tools. A stock "set" would be of little value to either.

It is well, therefore, to acquire tools as the need for them arises. In this way, the craftsman not only avoids condemning a lot of perfectly good steel to rust and idleness, but comes to know the tools he does buy, learns to depend upon them as upon old and tried friends, gains confidence in the powers they confer upon him.

If one supplies his needs in this frame of mind, it is unlikely that he will need to be advised against buying cheap tools, which are, like most other cheap things, a snare and a delusion. The better hardware stores are likely to have a choice among the higher grades of tools, so that the buyer is able to select just what will best fit his own requirements.

The following brief descriptions of tools and their purposes must necessarily be limited to those that are likely to be useful enough to warrant their purchase for the more common branches of home craftsmanship. Only such tools are mentioned as come within the scope of the several crafts here discussed in their respective chapters. Other craft activities, such as metal working, lathe work, wood carving, radio construction, jig-saw work, etc., fall outside the scope of this book and are generally to be found thoroughly described in special volumes.

CARPENTRY TOOLS

The list of tools used in woodworking is so long that it seems well to divide it into groups: (*a*) tools for measuring, marking, and testing; (*b*) tools for cutting; (*c*) tools for driving; (*d*) tools for holding and cramping; (*e*) tools for sharpening; and (*f*) a few miscellaneous tools that come under none of these heads.

Tools for Measuring, Marking, and Testing. The pencil is used for rough marking and for indicating corresponding points on adjacent surfaces, but the marking awl gives a sharper line and is far preferable for close work. For a lengthy line, as in ripping a long board, the chalked cord is useful. It is fastened at the end in a notch or with a brad, held taut to the proper mark at the other end, and then snapped by being plucked up at the middle. The result is a clean, straight chalk mark.

A folding two-foot or three-foot rule is an essential, though the large steel square and the small try-square, with a six-inch or nine-inch blade, are always marked off in inches, enabling the worker to combine the operations of measuring and of securing a right-angle marking or test.

The Steel Square. The standard steel square is a very mysterious box of tricks to those who are not familiar with its many aids. With it, the carpenter makes all sorts of computations that would seem to require the help of a drawing-board, T-square, protractor, and slide rule. Time and ingenious men have added a number of helpful features to what was originally merely a right-angle marked off in inches, although probably most laymen think it no more than that to-day.

Of the standard steel square, one arm is 24 inches long and 2 inches wide, and is called the "blade." The other arm is $1\frac{1}{2}$ inches wide, varies in length from 14 to 18 inches, and is known as the "tongue." The two flat sides of the square are called, respectively, the "face"— always stamped with the maker's name — and the "back."

On its face, in addition to the scale of inches along each inside and outside edge (always reading from the corner outwards), the tongue has, in the middle, a pair of parallel lines. This is called the "octagon scale", and is divided into five parts to the inch and numbered 10, 20, 30, 40, 50, etc. To lay out an octagon measuring 5 inches between opposite sides, draw a square of 5-inch side and bisect it both ways perpendicular to the sides. Then, to find the length of the octagon side, place one leg of a pair of dividers at zero on the octagon scale and move the other leg to 5. This will be half the length. Mark this distance

off on each side of the square first drawn, starting from the intersection of the bisecting lines and working in both directions. The new points established will locate the external angles of the octagon.

It is possible, also, to construct any of the commonly used polygons by utilizing the fact that any angle can be laid out with a square, provided that one starts the line at a given point on the tongue — say 12 inches — and knows the height it will intersect on the blade.

In the same way, various angles may be laid off with the square if the more convenient protractor is not available. Starting at 12 inches on the outside of the tongue, the following heights on the outside of the blade will give the angles listed:

$1\frac{1}{16}$ inches — 5°	$5\frac{19}{32}$ inches — 25°
$2\frac{1}{8}$ inches — 10°	$6\frac{15}{16}$ inches — 30°
$3\frac{7}{32}$ inches — 15°	$8\frac{13}{32}$ inches — 35°
$4\frac{3}{8}$ inches — 20°	$10\frac{1}{16}$ inches — 40°
12 inches — 45°	

On the opposite side of the tongue, its back, there will be found, in the middle, the brace rule. This brace is the diagonal side of a right-angled triangle, of which the three lengths are given thus: $\frac{24}{24}$ 33.95, or, again, $\frac{33}{33}$ 46.67. The two parts of the fraction are the lengths of the two sides at right angles; the number following, with its decimal, is the length of the diagonal.

The back of the blade has through the middle a series of parallel lines inclosing seven spaces. In these spaces, numbers appear below each inch division marked on the outside edge. This is a table of board measure — a board foot being the contents of a board one foot (12 inches) square and one inch thick. Under the 12-inch mark will be found 8, 9, 10, 11, 12, 13, 14, and 15, in the column. These numbers represent the length in feet of boards ordinarily sold, and also the number of board feet in a 12-inch board so many feet long. Now, if we want to find the number of board feet in a piece 15 feet long and 14 inches wide, we follow along the bottom of the columns, in line with 15 under 12 inches, until we come to the number listed under 14 inches on the edge. The result shown is 17 feet, 6 inches.

The square is used in many other computations. Most of these have to do, however, with the framing of buildings, and so need not be discussed here.

A straightedge, at least three feet long, is useful, and it is usually well to combine with it a pair of spirit levels. A straightedge good enough for most purposes can be made in the shop, but a flat steel one is far better in that it cannot warp. To it may be fastened a spirit level made for the purpose. A plumb bob and line are occasionally needed, and are sometimes combined with the straightedge or the level.

Closely allied to the try-square is the adjustable

bevel, the blade of which may be fastened at any angle to the stock.

A marking gauge is a convenient tool for scribing a line at a given distance from the edge of a board and parallel to it. It is in effect simply a square stick (or metal rod) sliding through and clamping into a block, the stick carrying a sharp spur near one end.

A miter box, homemade if desired, but far more accurate and desirable if made with metal parts, permits the sawing of moldings, etc., at ninety degrees, forty-five degrees, or, with the more elaborate boxes, at any desired angle.

Dividers are not often needed; but if included in the equipment of the home workshop, they may well be of the type with wing and set screw.

A device not widely known, but particularly useful in boring holes to a given depth, is a bit gauge or bit stop. It clamps to a bit of any size and prevents its entering the wood beyond the prescribed distance.

Still another gauge that is very useful is some type of measuring gauge for ascertaining the diameter of bolts, dowels, bits, etc.

Tools for Cutting. Under this group heading come, first, the ordinary knife and, next, the hatchet, neither of which needs any description.

Among the many saws, a 24-inch crosscut is the first essential. For ripping boards with the grain, a 22-inch ripsaw will do the work much more

rapidly and easily because of its large teeth, though this work is possible with the crosscut. A backsaw — say 14-inch — is practically a necessity if one has much work with the miter box, and is a great convenience for sawing moldings and small pieces because of its fine teeth and the stiffening of the blade by the back strip of steel. A keyhole saw will probably be needed occasionally; and a coping saw, also, if any fine work with moldings, or any curved-line cutting, is done.

One usually finds a rather full array of chisels in any collection of tools, though the $\frac{1}{4}$-inch, the $\frac{1}{2}$-inch, and the inch widths should suffice for most purposes.

Similarly, gouges, which are chisels with concave blades, are made in sizes from $\frac{1}{8}$ inch up to $1\frac{1}{2}$ inches, but the $\frac{1}{4}$-inch and $\frac{1}{2}$-inch should serve nearly every purpose.

Both chisels and gouges are made in two types — tang and socket. In the former class, the blade is tapered to a tang, which is forced into a wood handle that is protected against splitting by a ferrule. Socket tools are of heavier construction, the steel of the blade being formed into a funnel-shaped socket that takes a tapered cone on the wood handle. The heavier tools are for mortising and similar work, in which the mallet or hammer is used to drive them.

The plane is in effect a chisel in a wood or metal block and is for the paring of larger surfaces. A

jack plane is perhaps the most essential — about 15 inches long with a cutter $2\frac{1}{4}$ inches wide. With its long base or sole, it serves to bring a surface to a fairly true plane and make it moderately smooth. When still greater smoothness is required, a shorter plane is used, called a smoothing plane, which will pick up irregularities that the longer plane rides over. For cutting across the end of the grain, a small steel block plane is useful; its blade is set at a smaller angle to the sole, and with the bit bevel above rather than below as in the jack and smoothing planes. These three are the most used planes for ordinary work, but there is a large group of special planes made for cutting rebates, grooves, tongues, and various moldings. These depend for their action upon specially shaped cutters and also upon what is called a "fence". The fence is a guiding block, usually held upon an adjustable arm or two, and rides along a near-by surface at right angles to the one being cut, thus keeping the groove or fillet straight and parallel to the long edge of the board.

The spokeshave is close kin to the plane, its blade slightly projecting through a guard held between two handles. It is used for paring cylindrical pieces or curved, narrow surfaces.

The file family is another fairly large one, of which the chief woodworking members are the rasps. A half-round combined with a flat sur-

face makes a particularly useful tool for abrading tenons and small blocks of wood to a final fitting size before the last sandpapering. In addition to the rasp, a 6-inch warding file, an 8-inch cabinet file, and an 8-inch triangular saw file will be useful.

A scraper is a tool frequently called into service, particularly for removing old paint from woodwork; and though the handled sort is more comfortable to use, the plain sheet of steel, about 3 by 6 inches, will serve very nicely at less cost.

In boring holes, the smaller diameters, if not too long, can be made conveniently by the use of the now almost universal spiral-ratchet screwdriver, the bit of which is replaced by a chuck and drill made for that purpose. For holes longer than these necessarily short drills, and for the larger diameters, the brace and auger bit are essential. When buying a brace, it is well to get one with a ratchet action, for this permits its use even in restricted positions where the full swing of the circle is not possible. A fairly complete set of bit sizes up to one inch is needed, and two adjustable expansion bits will carry the range from there up to 3 inches. With the auger bits, one will need a rose countersinking bit, and one or two screwdriving bits, which are useful in driving heavy screws or removing old ones that are firmly fixed. If flat-bottomed holes are required, they can be made with the Forstner type

of bit, which does all its cutting with a blade set in a cup at its working end.

For starting screws, a bradawl is almost essential — in effect an awl with a narrow chisel point. To get a starting hole for a screw, the bradawl should be forced in with the chisel edge always *across* the grain rather than *with* the grain, thus cutting the fibers and avoiding splitting them.

Tools for Driving. A hammer is the first essential tool — the nail-hammer type with adze eye, of about 16-ounce weight, being a good choice for general use. A 4-ounce riveting hammer is much easier to use in driving brads and for similar light work. Most carpenters, when driving a chisel, like to use a mallet; but if the chisel has a leather-capped handle, a hammer serves very well.

The household would undoubtedly have much use for a hatchet; and if one is not already available, it may be said that the claw type combines with the blade a convenient nail puller.

For a screwdriver, the spiral-ratchet form is a fairly recent improvement of unquestioned value, particularly since it permits the use of several sizes in the blade bits. For heavier work, however, a sturdy, rigid blade is practically a necessity.

Another minor tool that pays its way is the nail set, or punch for driving a nail beneath the

surface. Two sizes are useful. In a pinch, one of these nail sets can be improvised from a large wire nail, its point ground down and smoothly rounded.

Tools for Holding and Cramping. A pair of carpenter's pincers is considered an essential in most shops and is undoubtedly the best for withdrawing nails; but it is quite possible to get along without this particular type if one has a pair of side-cutting pliers such as will be needed for any work with wire.

In cutting two or more pieces of wood to match, a pair of carriage clamps or G-clamps will be found very helpful; and a carpenter's wooden handscrew of about 8-inch or 10-inch opening will assist in gluing pieces together when the span to be gripped is not too large. Larger work that must be cramped can be handled between the bench stops and the vise, or wedged tightly together on the bench with spare pieces and a few homemade pairs of wedges of sufficient length.

Tools for Sharpening. Since all tools used for cutting purposes in woodworking must be kept really sharp if satisfactory work is expected, a grindstone and an oilstone must be counted among the essentials. The old-fashioned large grindstone, with its water drip, has largely given way to the small wheel of carborundum geared up to fairly high speed through a hand lever or a foot treadle. This apparatus, with its adjustable tool rests, is used for the grinding of blades when this is needed, the finished keen edge being obtained by rubbing upon the finer surface of an oilstone. Of this procedure, more details will be found in Chapter V, "Keeping Tools Fit." With these two fundamental sharpeners — the grinding wheel and flat oilstone — a round-edged "slip" or thin stone will be needed for sharpening gouges and other curved cutting edges.

A grinder guide, in which is held a chisel or a plane cutter, facilitates the grinding and honing of a bevel at a definite angle — a rather difficult task in the unassisted hands of the novice.

The sharpening of saws is not such a difficult task as it appears at first glance — certainly not one to intimidate the home craftsman. A saw set is a tool used to bend the teeth in just the proper amount and at the proper angle from the plane of the saw blade; after which, they are sharpened with a small file of triangular section.

Miscellaneous Tools. An oil can, a glass cutter, a pair of tin-snips, and a monkey wrench are obvious necessities.

In place of the old iron glue pot, we shall want prepared liquid glue, casein glue and, for waterproof use, some plastic resin glue.

A cold chisel is frequently useful in opening boxes and prying apart nailed boards.

Sandpaper is dealt with more fully in the chapters on Painting (VIII, IX), but should not be

overlooked. For its proper use a holder is a great convenience, though the paper may be tacked about a waste block of wood to achieve the same results with a little more trouble and less expense. Emery cloth is at times necessary to remove rust from steel tools, though with care these times should be few and far between.

PAINTING TOOLS

In addition to paint brushes, which are described in the chapters on Painting (VIII, IX) and Varnishing (X), comparatively few tools are needed for the work included under painting. A putty knife is essential, and a pair of wire brushes is desirable — one wide, the other narrow. The cabinet scraper listed above will be called into frequent use in removing old paint, and for this purpose the wood rasp is often even more effective and easier to use. The removal of extensive areas of old paint outdoors would require too much prepared paint remover and is accomplished more easily with a painter's torch.

The glazier's points used in holding a pane in its rebate before puttying may most easily be driven in with the side of a heavy chisel, the bevel being held against the glass. Old ones may be pried out with a screwdriver. The glass cutter has been mentioned above. The type with a steel-disc cutter is satisfactory and far cheaper than the diamond cutter. Glass to be cut must

be laid upon a perfectly flat surface, and then the line to be cut can be indicated at each end by drawing a pencil line through a smear of putty or soap, and a straightedge can be used against these marks to guide the cutter. A bent piece of tin, to serve as a shield when one is painting next to a papered wall or other damageable surface, is described in Chapter IX, on "Interior Painting."

For rubbing varnished work, a piece of piano felt, about three by six inches, will be needed; also powdered pumice stone, steel wool in several grades, and, for outside rubbing, assorted degrees of coarse and fine sandpaper.

It will be found very convenient to have several gallon cans with spouts, such as are sold for kerosene, to hold a supply of turpentine, raw linseed oil, boiled linseed oil, and denatured alcohol. These had best be painted on the outside to prevent rusting, and lettered to indicate their respective contents.

PLUMBING TOOLS

The Stillson wrench is the chief tool in the plumber's kit, though the amateur will more frequently solve his simple troubles with monkey wrench and screwdriver. A "plumber's friend", as described in the chapter on "Plumbing" (XII), is useful to force a clogged drain. If, as is unlikely, the home craftsman attempts the

installation of new piping, he will need a pipe vise, threading tools, and a reamer.

ELECTRICAL-WIRING TOOLS

The side-cutting pliers, listed among the carpentry tools, are a necessity. It is possible that several long bits will be required for boring holes through partitions, beams, etc. These are used in the ratchet brace.

A small screwdriver for adjusting binding posts and socket fittings will also be needed.

MASON'S TOOLS

In addition to the straightedge listed above, with its spirit levels and plumb bob, two pointed trowels will be required — a full-sized mason's trowel and a smaller pointing trowel. If special pointing is attempted, such as a recessed half-round, or for V-jointing cement work, the corresponding pointing tools may be acquired later.

A sieve for screening sand may be made from galvanized iron mesh nailed to a box frame; and a shovel and spade will be needed — the spade for mixing mortar or concrete.

For plastering, a regular plasterer's trowel and a smaller size will be supplementary, with a large sponge or whitewash brush for keeping the plaster moist until fully troweled to a finished surface.

CHAPTER V

Keeping Tools Fit

A dry workshop will go far towards helping to win the never-ending fight against the greatest enemy of tools — rust. Nevertheless, a thoroughly dry shop is not always possible; and even if it were, much dependence must be put on the protective qualities of an oily rag, which is kept always at the bench and with which all steel parts, particularly saw blades and chisels, are wiped at regular intervals. Either sweet oil or vaseline is the proper protection, but not linseed oil, which oxidizes.

If a steel surface does become rusty, the deposit can be removed by rubbing with a gritty eraser or with fine emery cloth; but if the rust has been neglected long enough to permit of its eating well into the surface, the surface will be pitted; and if this happens on the cutting edge, the tool will be impaired.

Wooden handles are kept in excellent condition by wiping them occasionally with a rag well moistened with linseed oil. New wooden planes

are the better for a good soaking in linseed oil. An old method is to remove the irons, stop the bottom slot with putty, and fill the mouth full of the oil. This is allowed to stand until the oil penetrates the whole plane lengthwise with the fibers, finally exuding from the ends. After drying, the plane is well polished with a soft cloth.

Planes should not be stored on a flat shelf upon their soles, as this will dull the projecting cutting edge. Rest them on one side; or, if there is danger of their knocking against each other or against other tools, a pair of thin parallel strips tacked to the shelf will permit of their resting on the soles with a free space beneath for the edges.

The advantages of keeping most of the handled tools in racks have been mentioned in the chapter on the Workshop (III). This arrangement does not provide for such things as auger bits. These are particularly susceptible to rust, since it is harder to coat them completely with the protective film of oil. Wooden cases are sold for sets of bits; but inasmuch as one is frequently adding to his assortment, the case does not long suffice. A simpler and more adaptable method provides a block of wood sufficiently deep in the direction of the grain to hold the bit in a hole that has been bored with the bit itself. My own block has the front half cut down a step to take the shorter and smaller bores, the upper (back) row accommodating the larger ones. After the

block has been bored as desired, soak it well in oil. There need be no fear that a bit will rust in such a snug oily compartment.

Incidentally, this bit-block serves another purpose, for the easiest way to sharpen a bit is to revolve it back and forth in a hole of its own boring into which has been put a little grinding compound, such as is used by motor mechanics for grinding valves. The friction and slight abrasion at the outside cutting helix gives all the sharpening that is needed, excepting at the terminal spur cutters. These are sharpened with a small file, on the *inside* faces.

Grinding and Honing. Most of the cutting tools — plane cutters and chisels — are ground on

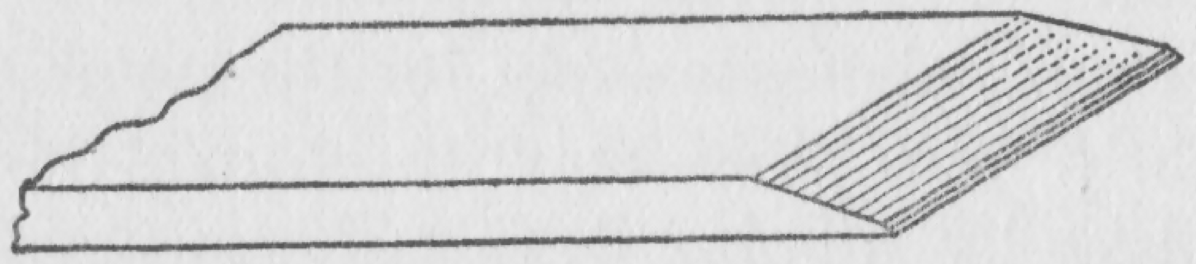

FIG. 2: The edge of a chisel or plane cutter consists of a double bevel. The lesser angle is made by grinding, the final cutting edge by honing.

the wheel to a bevel of from twenty to twenty-five degrees. This bevel does not run to the very edge. Its form is clearly shown in Figure 2. The final edge is a second bevel of from thirty to thirty-five degrees, worked by hand on the oilstone. It is a difficult matter to keep the face of this final bevel a true plane; it easily becomes rounded in the slight change in angle when the tool is moved back and forth on the oilstone. To

assist in true honing, there is a very simple grinding tracker, the roller of which travels on the bench beside the oilstone, insuring a fixed angle of tool to stone. Three or four minutes of honing, with some pressure exerted through the fingers of the left hand near the cutting edge, will usually be sufficient to bring back a keen edge. The tiny wire edge that remains on the flat side of the blade is then rubbed down by holding the chisel or plane cutter flat on the stone for a few final strokes. Sweet oil or neat's-foot oil is preferable for the honing lubricant.

Unless some care is used to rub over the whole face of it, the stone becomes hollow in the center and unfitted for honing a wide plane iron. If both sides of the stone are available, it is well to reserve one side exclusively for the plane cutters. A slightly worn stone may be brought back to a true plane by rubbing it, face down, upon emery cloth fastened to a perfectly true-surfaced board. An occasional cleaning of the face with turpentine will remove the accumulation of dirt; and immediately after this, the stone should be wiped dry. Keep the stone at all times in the wooden case that comes with it or may be made for it.

The English craftsman, who for the most part uses wooden-wedge planes rather than the improved adjustable planes of American manufacture, prefers to sharpen his plane cutters with their corners very slightly rounded. American

planes, however, with their greater nicety of adjustment, are always sharpened with a perfectly straight cutting edge; and this edge must, of course, be ground truly at right angles with the length. Unless the cutter is evenly held, with pressure exerted across the whole face, it is very easily honed out of true. An occasional test with a try-square during honing will help to correct this fault.

The gouges are more difficult to grind and hone properly, since they must be evenly and steadily revolved through the cutting arc. A lighter pressure and slower honing than are used with the flat edges will help keep the cutting arc true. With the gouges, the grinding and honing angles coincide. The grinding is carried on until the line of the edge is just barely visible; after which, honing brings the keen edge recognized by the fact that, when wiped clean of the oil lubricant, it is not visible to the eye. The wire edge on the inside is removed by a few light strokes of what is called an "oilstone slip" (a stone with a rounded edge), laid close in the channel of the blade.

Paring gouges, which are beveled on the inside, leaving the outside edge straight, are rather beyond the skill of the amateur and had better be sharpened by a skilled tool grinder.

The cabinet scraper receives very hard usage, particularly when employed in scraping paint

from old woodwork. For this work, the edge may be made sufficiently keen by grinding it down on the side of the wheel, or by filing it while held upright in a vise. Care must be taken to keep the edge at a true right angle to the sides. The scraper becomes a very different tool, however, in the hands of a skilled worker when he wants to smooth up the surface of a piece of curly-grained wood, a veneer, or something of the sort that even a smoothing plane cuts too deeply. For this work, the scraper is not pushed away from the worker at a sharp angle to the surface, but is held more nearly vertical and either pushed away or drawn towards him; and its edge must be sharpened in such a way that it becomes a very fine cutting tool. To sharpen it for such work, the edge is first ground on the side of the wheel, or filed; after this, it is honed on the side edge of the oilstone (to avoid grooving the face of the stone). When the edge is smooth and true, the scraper is laid flat on the bench, with its honed edge along the outside edge of the bench. With the back of a gouge, a nail set, or some similarly rounded piece of hard steel, burr the edge to project slightly in the direction of the honed surface. Do this at both sides of the edge. Then, holding the scraper in the vise, burred edge up, turn the burrs over to the outside by stroking the scraper in one direction — first, directly across, and then in the reverse direction (downward).

On each side, this should be done at the same angle — about sixty-five degrees. The desired result is shown in exaggerated cross section by the diagram (Figure 3). Finally, the corners are very slightly rounded off by honing.

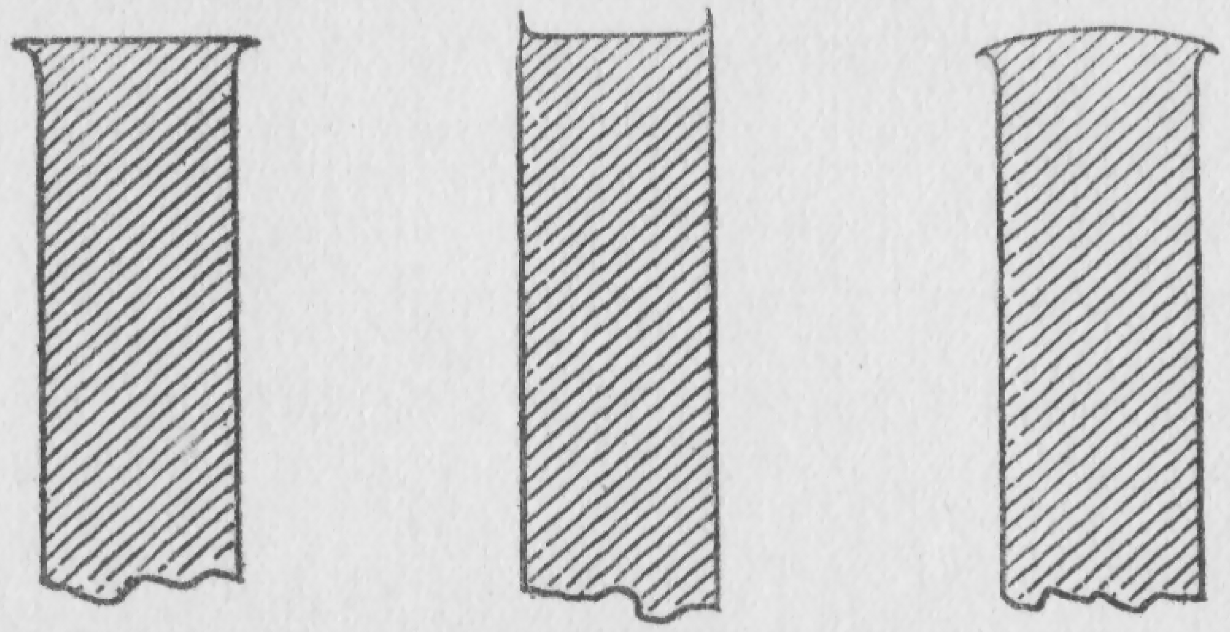

FIG. 3: The three stages in the sharpening of a cabinet scraper, shown in greatly enlarged section. The first, at the left, results from grinding or filing; the second, from burring the feather edge forward with a hard piece of rounded steel; and the final stage, from turning this burred edge over to the side with the same instrument. (The back of a gouge works well.)

Sharpening Saws. The action of a saw depends upon the cutting edges of the front faces of its teeth. The teeth are " set " to slant slightly beyond both faces of the blade, alternately to one side and to the other. This set causes the teeth to cut a channel, or kerf, wider than the thickness of the blade, and it thus provides easy clearance for the blade, which would otherwise tend to bind. The extent of this set is very slight on the fine-toothed backsaws for delicate work, and greater on the coarser crosscut saws. To set a saw, the blade is held between two strips of wood in the vise, its teeth projecting between the top faces. A setting tool, by a compressive action of the

right hand on the grips, bends each alternate tooth away from the worker to just the proper degree. When one side has been set, the saw is turned end for end, and the remaining alternate teeth are set in the same manner. The teeth

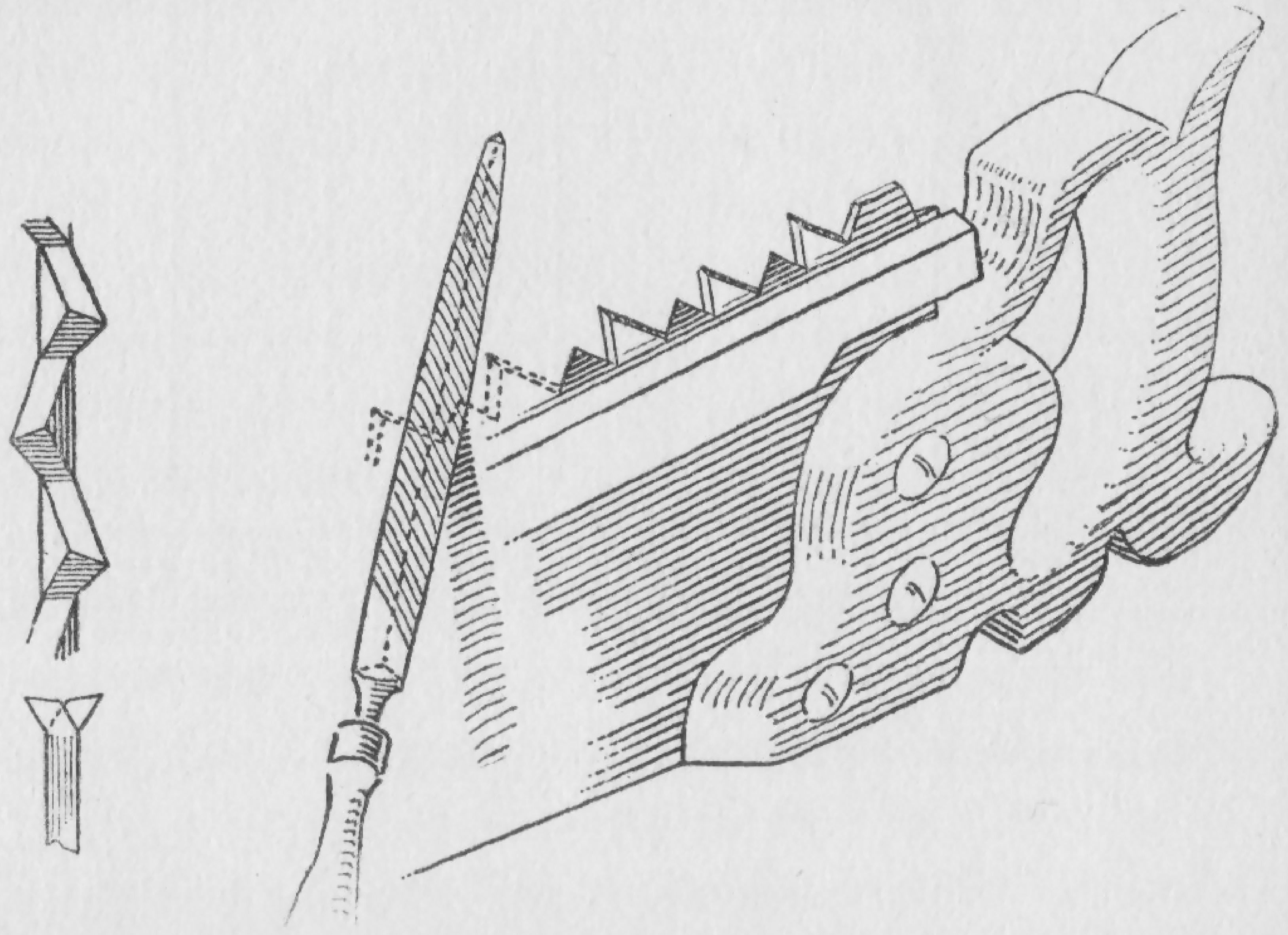

FIG. 4: The saw is sharpened by clamping it in a vise or rack between two strips of wood and filing the front edge of the teeth projecting towards the worker. The three-cornered file is held as shown, to produce the cutting edge on the outside of each tooth. When all the alternate teeth have been sharpened, the saw is reversed and the opposite teeth are filed in the same way. The file is always pointed upward and towards the saw handle. At the left is an enlarged view, looking down upon the teeth, and below it a cross section. If the saw needs setting, this is done with a special tool before filing.

are then sharpened with a small file of triangular section, while the blade is held tightly between the same strips of wood extending the full length. On the alternate teeth projecting towards the worker, the inside front edge is filed to give a sharp wedge to each tooth (Figure 4). To do

this, the file is held pointing upwards at fifteen degrees to the horizontal and also pointing towards the handle end of the saw at an angle of, say, twenty-five degrees from the blade. The file cuts on the forward stroke, thus preventing burrs on the cutting edge of the tooth. It has the additional effect of beveling the back edge of the alternating tooth next to the file on the far side of the blade. After the teeth on the near side have been filed, the saw is turned as before and the alternating teeth are sharpened in like manner. If the wooden strips are too wide to permit the use of the file at the proper angle, their outside top faces may be chamfered.

The screwdriver does not often receive the sharpening that its constant use deserves. The edge should be squared across, so that it sinks into full contact with the screw's groove; and it should be thick enough at the edge so that it will not ride up out of the groove and spoil the groove's sharp edges. A squarely ground wedge shape, thick enough to fill the groove of screws on which it is used, is best. This wedge shape is most easily secured on the grinding wheel.

CHAPTER VI

Operations in Woodworking

The craft of working in wood — carpentry — consists of a knowledge of, and skill in, a very few operations, together with a knowledge of various joinery methods. The operations are sawing, planing, chiseling, and boring. None of them, in principle, is difficult to learn. One may soon become passably proficient in all four. Yet each is so dependent upon experience and practice that skill is constantly developed and complete mastery is seldom reached. That is undoubtedly one of the greatest charms about working in wood; skillful as one may become, greater facility and more nearly perfect results always beckon just ahead.

Sawing. Before a saw-cut of any kind is made, the wood should be marked. For rough work, a pencil line will serve, drawn across the piece with the guidance of the try-square if the cut is at right angles, or with the bevel if the cut is at some other angle. For more accurate work, the marking awl gives a sharper line. For ripping a long

board, the snapped chalk line will do, or a marking gauge. For small, accurate work, such as laying off a tenon or mortise, the marking gauge is usually employed (Figure 5). In using this tool, the proper width is set either by measurement or by the scale on the tool itself; after which, the main thing is to hold the block squarely against the guiding edge. The spur is slanted, so as to drag its point, rather than held vertically; and it is very lightly pressed into the wood, else it may follow the grain and throw the block away from the edge. Two or three scorings are usually necessary if hard wood is being worked. Marking only the top surface is sufficient for a thin piece, but for heavier work or for fine, small work in tenons, mortises, dovetailing, etc., the scoring is carried around on three, or even all four, sides.

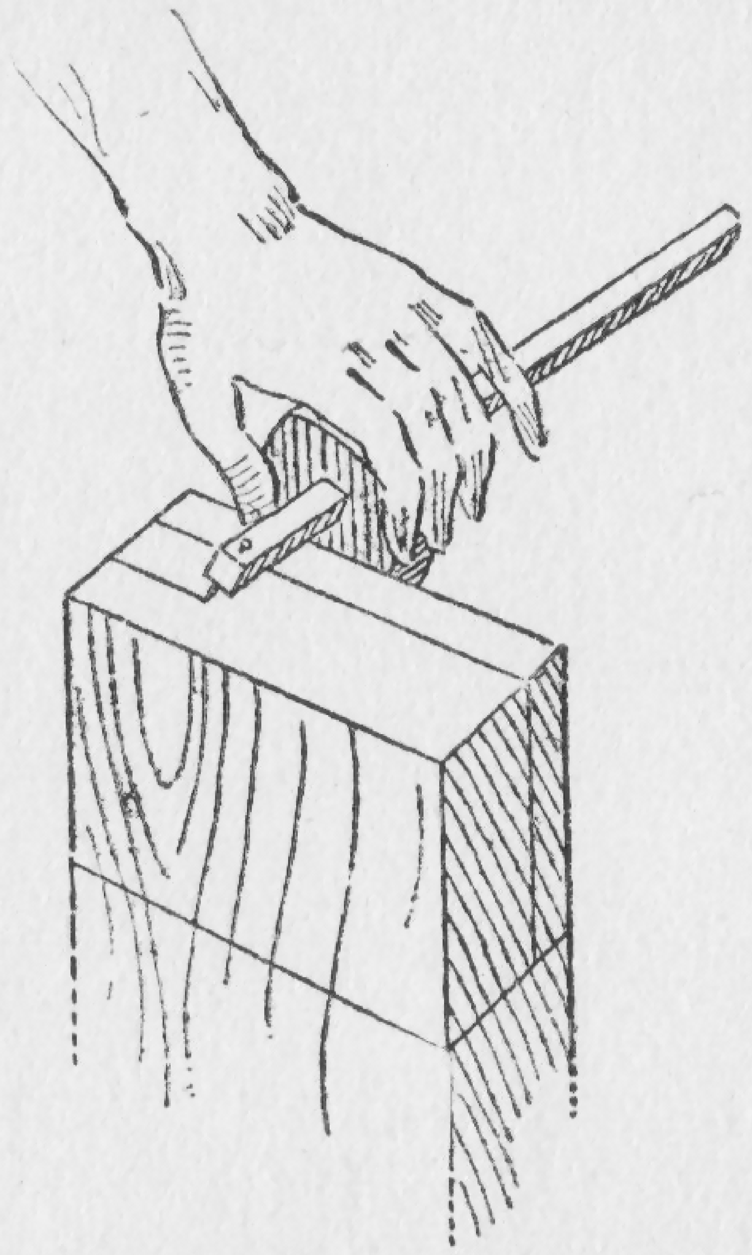

Fig. 5: The use of the marking gauge. The block is held against the guiding edge of the board and the spur is tipped at an angle as it is pushed away from the worker, so that it will not catch in the grain.

Marking the line to be cut is by no means sufficient. A saw-cut has a width of its own, amounting to, say, $\frac{1}{16}$ inch. Accurate sawing is

always done on one side of the scored line. Our line gives us a width of strip or the thickness of a tenon; the saw-cut, then, must be outside of this mark, not inside of it, nor even on it, if the measured width is to be left whole. On the other hand, if we are sawing a mortise or a slot or a notch, the saw-cuts will be inside of our scorings, else the portion cut away will be too wide. In a word, cut always on the waste side of the line. If we leave too much wood, it can be planed or chiseled off; if we leave too little, there is no way to put it back.

To presume to tell any man, or even boy, how to saw seems as unnecessary as telling him how to play baseball. Nevertheless, since there are men who never seem able to catch the knack of it, it may be worth while to mention several points that make the operation easier and more accurate. Start the kerf by drawing the saw backward, several times if necessary, guiding its blade to the mark by the first joint of the thumb — and always remember that that thumb is in danger. All the cutting action is on the forward stroke; so confine the downward pressure of the wrist to that half of the movement. Do not grip the saw too tightly; to do so is tiring, and also tends to swerve the saw from the line. Cultivate a long stroke — nearly the full length of the blade, rather than a rapid one. A 45-degree angle is perhaps the easiest; flatter sawing, in an

effort to follow more of the guide line on top, is less efficient. In shallow sawing, as on the side of a tenon, it is necessary, but so much more difficult that a backsaw and miter box are usually employed. Holding the saw in the plane at right angles to the wood is the most difficult part of the operation of sawing; it is a matter that must be governed entirely by the eye and is mastered only with practice. For the beginner, an occasional test with the try-square will help to cultivate an instinctive feeling for the true right angle. It should be unnecessary to say that the line of vision should be directly above the saw-cut and the blade held so that only its top edge is visible.

The ripsaw, used for cutting in the direction of the grain rather than across it, has very much larger teeth and a less angular set, and does its job much faster. The work, if of some length, is best supported on a pair of sawhorses and held firmly down with the knee. Here, again, the 45-degree angle is best for the blade. Short cuts are often made while holding the piece upright in the vise, but any sawing is easier when the wood is held low enough to bring the shoulder over the saw handle.

Planing. The operation of planing, if one's tools are sharp and properly set, is one of the most pleasurable in woodworking. The plane is in effect a chisel set in a block and projecting

just enough to take a very thin shaving from the surface being worked. The curl of these uniformly thin shavings up through the mouth of the block at each long, easy stroke, the characteristic aroma of essential oils released from the freshly exposed wood, and the progressive smoothness of the piece being worked form one of the composite delights of the carpenter.

For the first rough surfacing of a board, the jack plane is the essential tool. Its long sole preserves the general plane of the surface, shaving off the high points and riding over the hollows. Its use is followed by that of the smoothing plane — shorter of sole and therefore adapted to picking out the smaller irregularities of surface for leveling. Its bit should be set with the very least working edge.

Marking with the gauge on both sides of the board's edge will furnish a guide for planing; and a straightedge held close to the surface, between the eye and the light, will help to reveal inequalities. Sighting along the edge from one end is not altogether reliable as a test, unless one is thoroughly experienced.

One of the most common faults in planed work lies in failure to keep the edge at a true right angle to the adjoining surface. In the case of the narrow edge of a board, neither the try-square nor straightedge will clearly reveal this. The best test is by the use of so-called "winding strips"

(Figure 6). With one of these true edges across either end of the board, each parallel to the other, a sight across their top edges will reveal even a slight twist in surfacing. The diagram will make clear this method.

In planing with the length of the grain, care should be taken to plane in the direction in which

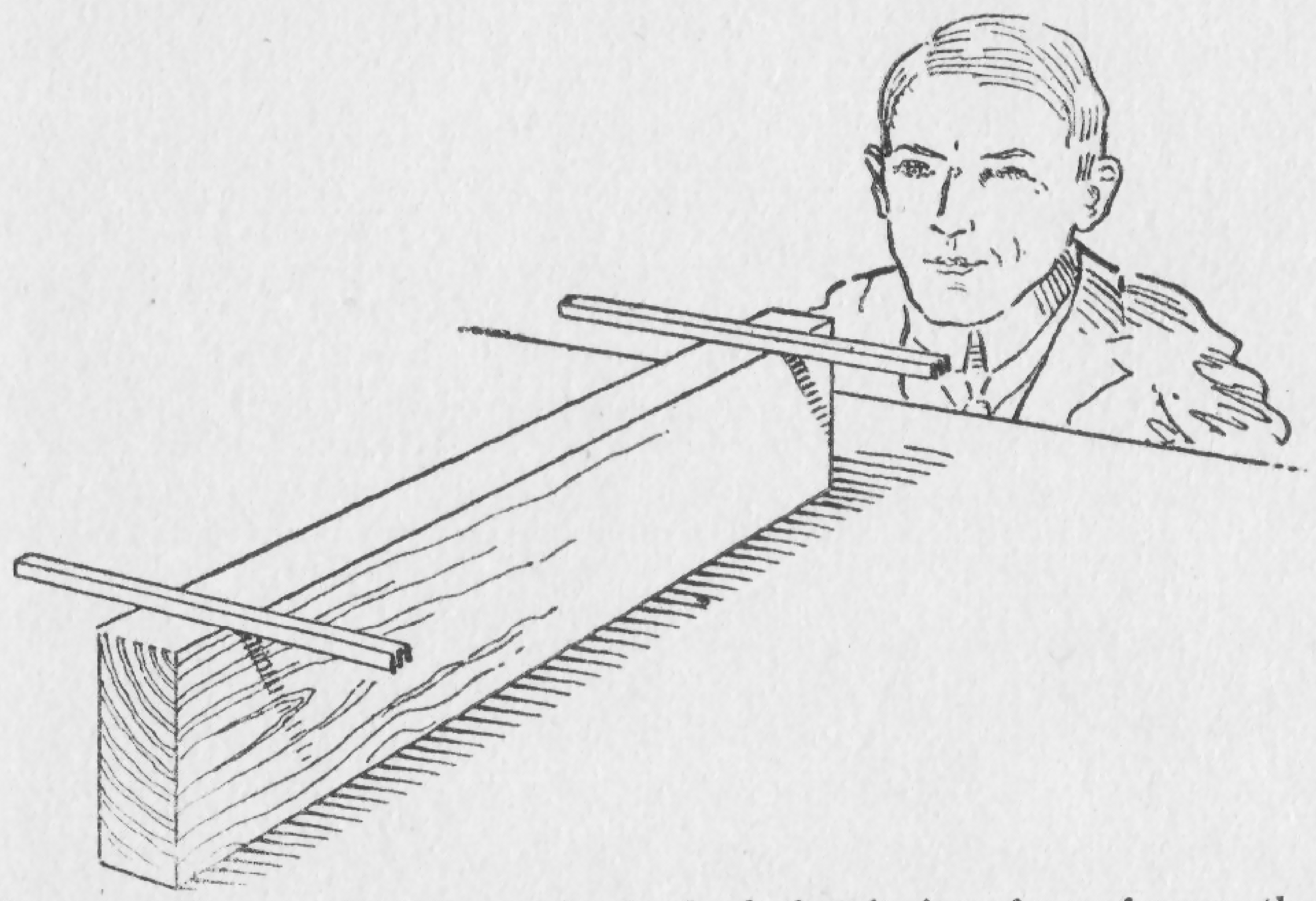

FIG. 6: The use of winding strips to check the planing of a surface, so that it will be free from twists.

the grain runs down from the plane; otherwise the bit will pick up the ends of fibers and split them off. With irregularly grained wood, it is sometimes necessary to change the direction of planing on various portions of a long surface.

For planing the end grain, a sharper angle of the cutter is provided in the small block plane. In hard woods, the operation is difficult at best, and

is likely to result in the splitting off of fibers at the far end of the block. This is prevented by clamping a piece of waste tightly against the far end of the surface and planing across this additional surface in the stroke. Or, if the piece is long, the planing may be done from both ends and stopped before the far end is reached.

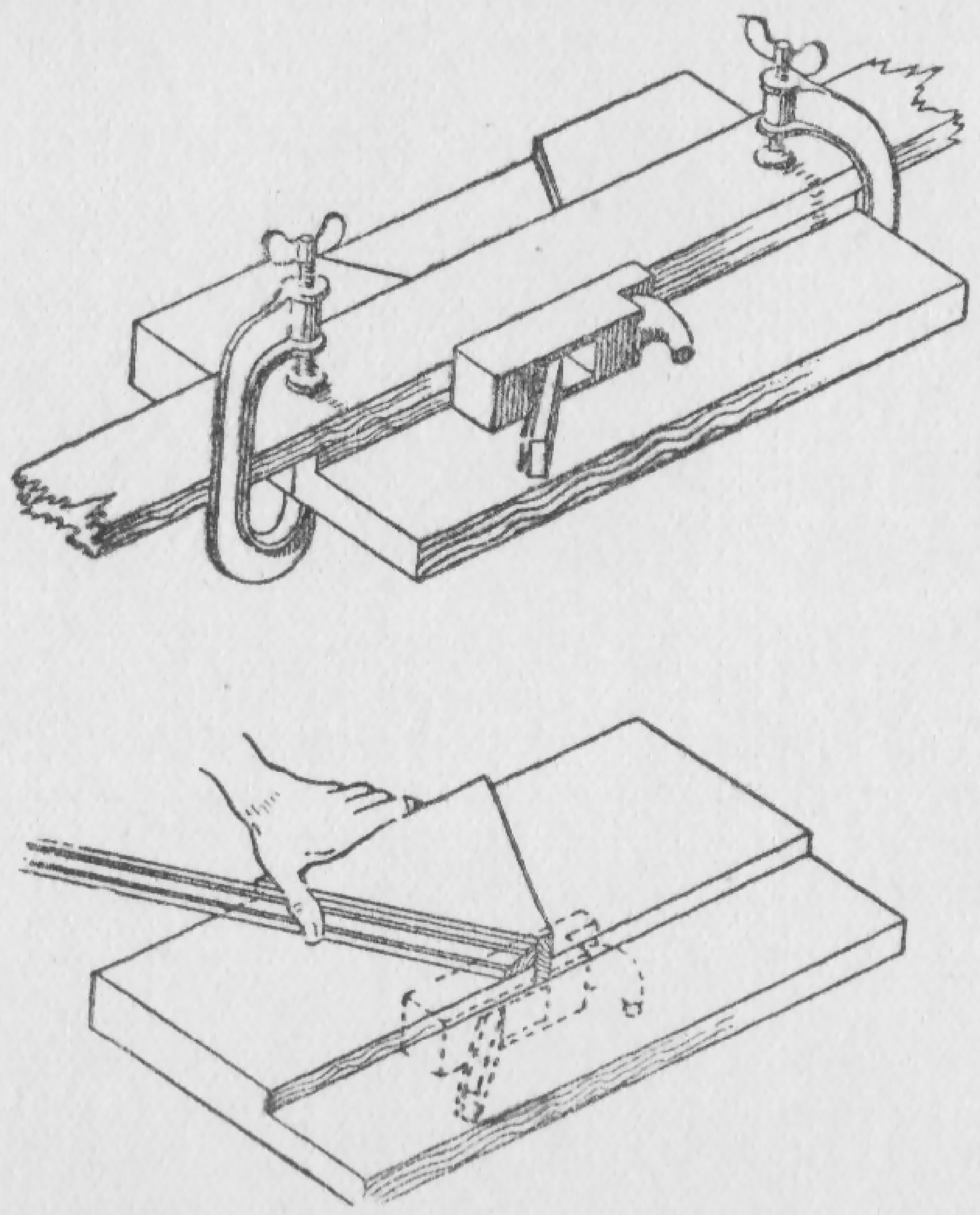

FIG. 7: A shooting board adaptable for both straight and mitered work. The three-cornered block is securely fastened into the sinkage made for it, when mitered work is to be planed.

For particularly careful work, when the surface must be absolutely true (as, for example, across the mitered edges of a picture frame), it is customary to utilize what is called a "shooting board." This is a device for holding the piece to be worked while the plane is held to a true course by a runway guide. Such a board can be made of maple or other hard wood, in some such form as that shown in the diagram (Figure 7). It is also available in machined steel, with a special plane attached; but this is an expensive tool.

Similar in principle are the many varieties of rebating, plowing, and molding planes, the more elaborate of which carry their own "fence" or sliding block. This, when held in contact with an adjoining surface, guides the cutting in a parallel line. With these planes, it is comparatively easy to do such work as rebating, tongue-and-groove jointing, beading, and even the more elaborate moldings. If much of this kind of work is contemplated, it would be advisable to procure an adjustable molding plane, of which one of the more elaborate patterns is shown in the illustration of planes in back of book. With this tool it is possible to cut a window-sash molding in one operation, as well as to do the simpler rebating, beading, grooving, etc. Instructions for the adjustment and use of such planes come with the tool itself. It and a still more adaptable model of the same type are probably the most intricate and ingenious tools in the carpenter's equipment.

Sandpaper is usually the final accompaniment of planing a surface, and the paper is used to best effect when tacked over a true-surfaced block or held in one of the holders sold for the purpose. In the case of moldings or fillets, a specially formed holder may be made to fit the profile required.

Chiseling. In making interlocking joints of the many types that have been developed through the ages, the flat chisel is the one indispensable

tool. It serves as no other tool can for removing the waste wood from mortises and dovetailing, and in paring operations such as chamfering. Unlike the saw and the plane, the chisel in its various sizes is adapted to paring both with and across the grain. More than all other tools, it depends upon its keen edge, which, for good work and the craftsman's comfort and pleasure in working, should be kept at razor-like sharpness. Although the chisel is much used by many workers as a tool that is driven by a mallet blow, splitting off wood waste, yet its best use, to my mind, is strictly as a paring tool, gently pushed rather than driven, the great help of its sharp corners being utilized with something of a sliding rotary motion. I find it much easier and more satisfactory to do the rough work of waste removal by means of saw and auger, saving the keen edge of the paring chisel for the finishing of the work to the last degree of precision. As with planing when one is working across the grain, the paring operation is not carried off the edge from the middle, on account of a similar danger of splitting off end fibers; chiseling is done from the outside edge in towards the center.

Boring. The operation of boring in wood is perhaps less frequently done for the purpose of securing a round hole than for that of removing waste wood in a place that is brought to its final shape by chiseling. Mortising, for example, is

far more easily done by boring and then finishing with the chisel than by chiseling alone. The details of making the common mortise-and-tenon joint will be taken up in the following chapter. Boring offers only one difficulty — the preservation of the proper direction of the hole. Usually this is at right angles to the surface plane of the work. The most comfortable position for the brace and its auger bit is with the swivel top held against the body. This prevents, however, a vertical sighting such as is employed in sawing. Consequently, the eye must judge from an outside viewpoint whether the bit be vertical to the work; and only with considerable experience, or because of a natural gift of judging angles in this way, does the craftsman come to depend upon his accuracy in this regard. A trial sighting from the side — both lengthwise of the work and across it — is a good precaution to take just after the bit is started, with a similar checking-up occasionally as the hole deepens.

In boring through a wide board edgewise, it is almost impossible to be sure of coming out in the middle of the far side. For a case of this kind, or when a hole has to be bored accurately at an acute angle into the work, the use of a jig is necessary. This consists, in its simple form, of a block bored lengthwise with a hole of the diameter to be used in the work itself. The block is secured against the piece to be bored, with careful

testing for its position and angle. The accompanying diagrams (Figures 8 and 9) make clear two adaptations of this jig principle. In the first, the top edge of the board must be absolutely true; so, also, the guiding block, both as to its outside faces and as to the perfect centering of the bore. Then, with the use of waste pieces of uniform thickness, the

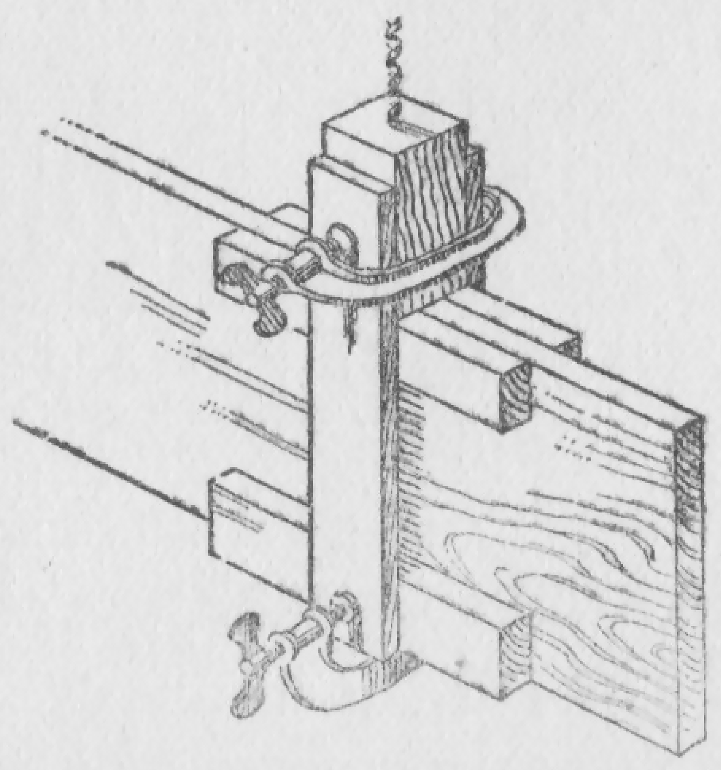

FIG. 8: Boring through a board edgewise by using as guide a trued block, held by clamps.

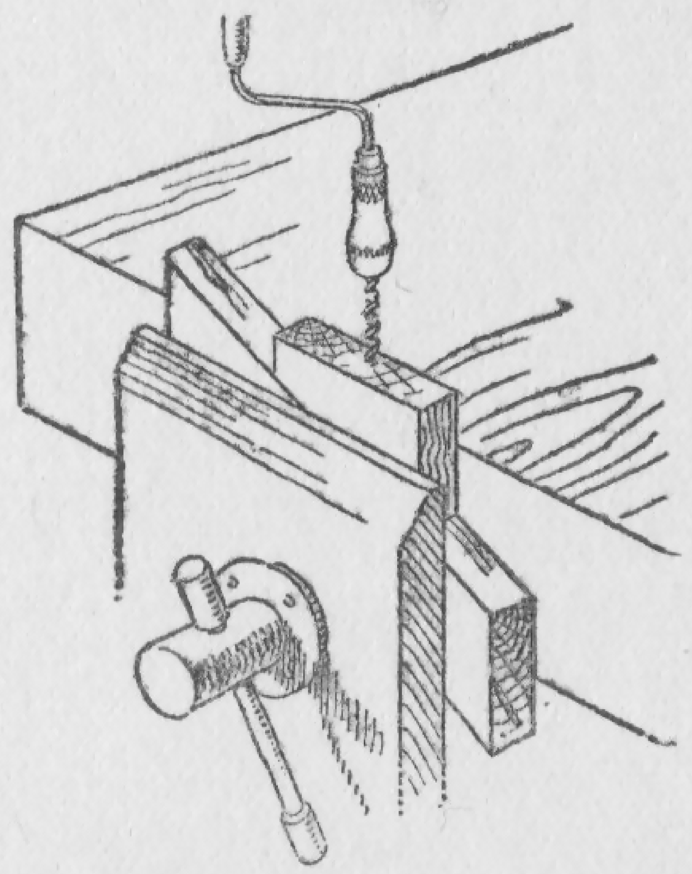

FIG. 9: In much the manner of edgewise boring (Fig. 8), a hole may be bored at an angle. The guiding block should have its lower face cut at the desired angle and be clamped securely to the piece that is to be bored.

continuation of the bore should go straight through. A long bit is needed.

The ordinary auger bit has a center screw at its cutting end, to secure accurate centering and to gain an advance hold for the spur cutting edges. When it is desired to bore a hole with a flat bottom (in thin stuff, for example), the point prevents this result. A bit that is designed on a different principle, with its cutting edges at the extreme

end, is called the Forstner bit. At starting, it must be centered by its circumference rather than a center point, but its form makes easy the flat-bottomed hole.

In much of the boring that has to be done, particularly in mortising, a series of holes is required, all of accurately uniform depth. This is secured with any type of bit by the use of a bit gauge — a stop that is clamped firmly to the bit to prevent its going beyond the desired depth.

In boring holes across the grain of a piece of wood, there is a tendency to split off fibers at the point where the bit emerges. Clamping a fragment of waste on the exit edge of the piece of wood will prevent this; or a clean edge is secured by stopping the boring as soon as the center point comes through, and finishing the hole from this point as a new center for boring in the opposite direction.

Tapered holes are made by first boring with a bit of the smaller diameter required, and then enlarging the bore to a tapered hole by the use of a tapered bit.

As has been explained in Chapter IV, "The Selection of Tools", it is customary to use an expansion bit for the diameters from one inch up to three inches. This type of bit may be set to any size within its limits by moving a sliding spur cutter out from the main stock and locking it with a set screw.

Counterboring — an enlargement of the hole for a short distance — is easily secured at the end of a boring by the use of a larger bit; or, for a beveled screw head, countersinking is accomplished by the use of a "rose bit", which reams out a flare at the end of the hole already bored.

CHAPTER VII

Wood Joinery

A knowledge of the operations in woodworking, such as has been indicated in the previous chapter, is perhaps as far as most men go in the craft. Knowing how to drive a nail, saw up lumber as needed, bore a hole now and then: these usually are considered the whole of an amateur carpenter's education. Yet beyond this primary education lies a great field that holds the keenest enjoyment for the craftsman — a field that constantly opens up new and fascinating vistas of achievement worth while. For the man who has glimpsed the intricacies of this field, the use of nails betokens a very low order of work; even carpentry that depends upon the more sophisticated screw is to him merely for the temporary and hasty job. By his critical eye, a piece of woodwork is judged not for its smooth surfaces, sharp edges, neat joints, and suitability to its purpose, but rather for that which is not apparent at all upon the surface — the intricacy and craftsmanship of the joinery. Joinery might be termed "carpentry

with a college education." It is as far advanced beyond its fundamental basis as radio wiring is advanced beyond bell wiring, and holds a corresponding fascination for him who is not satisfied with the easy accomplishment of the primary class.

All that this chapter will attempt is a survey of the joints themselves. The execution of these, their incorporation into the design of a piece of woodwork, and the combining of two or more of the joints at a single juncture must be left to the amateur craftsman's developing knowledge, skill, and experience.

One fundamental rule, however, may be laid down at the outset, and it were well if it could be engrossed and hung above the workbench: "Mark carefully, completely, sharply; and cut *in the waste.*"

Joints. After the plain butt joint, which brings two surfaces together and holds them by gluing, nailing, or screwing, the simplest is the lapped or halved joint, in which both members are cut away in such fashion that the remaining wood maintains the same thickness in combination as either piece measured originally. When fairly heavy timbers are halved, a wedge-shaped halving is sometimes employed in order to conserve more of the strength of the remaining sections and to help in avoiding splitting.

The notched joint is similar, and is used when one member crosses and is supported by the other;

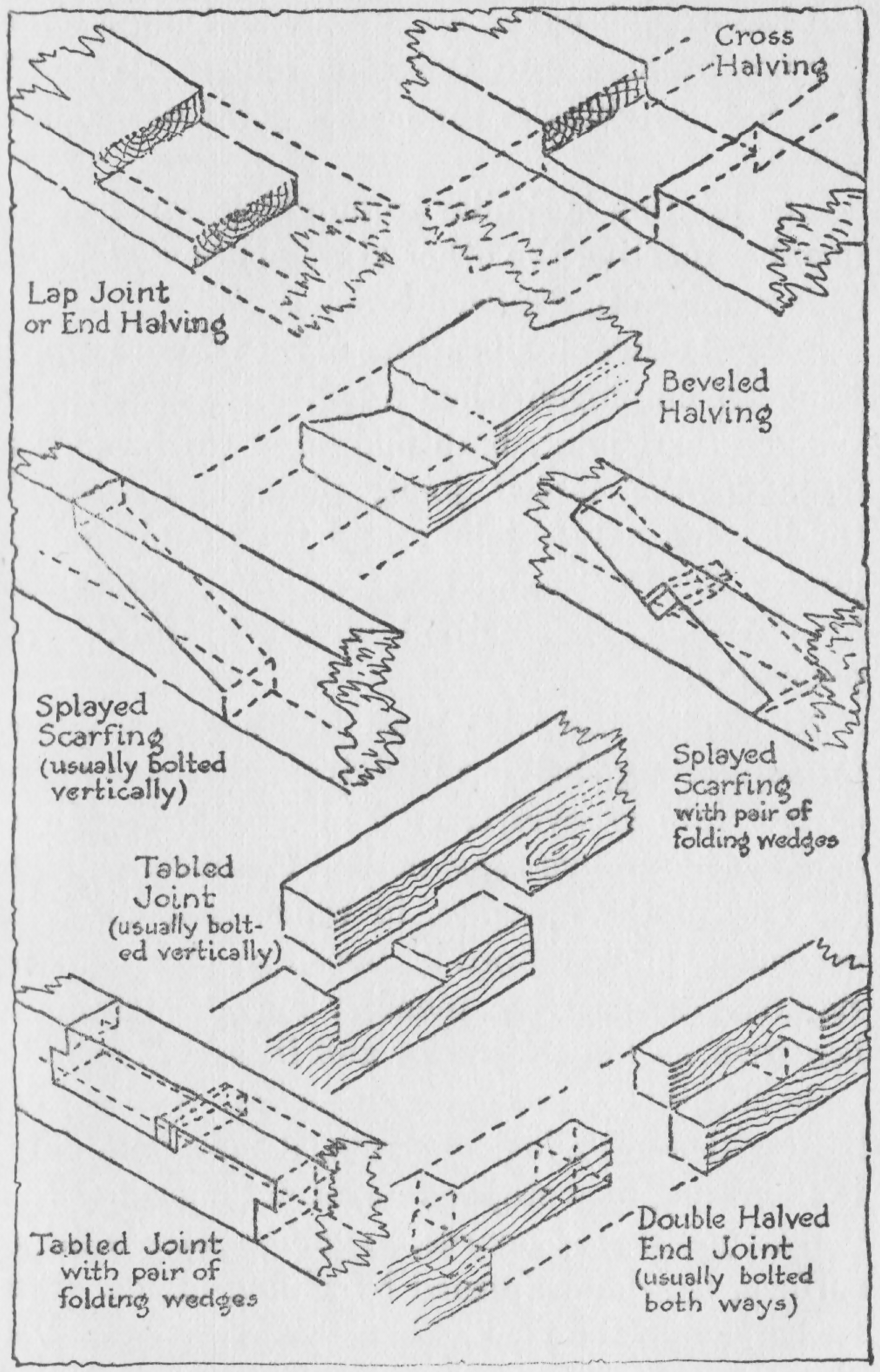

FIG. 10: Halved, splayed, and tabled joints.

but less wood is cut away, and the outside surfaces are not brought into the same plane. A modification of notching is the cogged joint or shoulder notch.

Toe jointing is similar to notching, but has one member meeting the other at an acute angle, such as is required in diagonal bracing.

Several other modifications of the lap (or lapped) joint are employed when a splice is needed: the splayed scarf joint, both plain and with a pair of wedges; the tabled joint, plain and wedged; the beveled halved joint; and the double halved joint. The last-named is further strengthened by doweling, the method of which is fully explained later.

Housing is the joint most familiar as a device for supporting shelving by letting the ends of the shelves into grooves formed in the upright members. The groove may not be extended fully to the face of the uprights, in which case the joint is called a "stopped" housing. For greater rigidity, the shelving member may be let in for less than its full thickness, and it then is called a "shouldered" housing. Moreover, if the joint is to withstand a lateral strain, it may be a dovetail housing, or a stopped dovetail housing.

Butt jointing of boards, to gain greater width of surface, is seldom formed by gluing alone. Battening across the back, when this is not otherwise objectionable, is an easy way of holding together

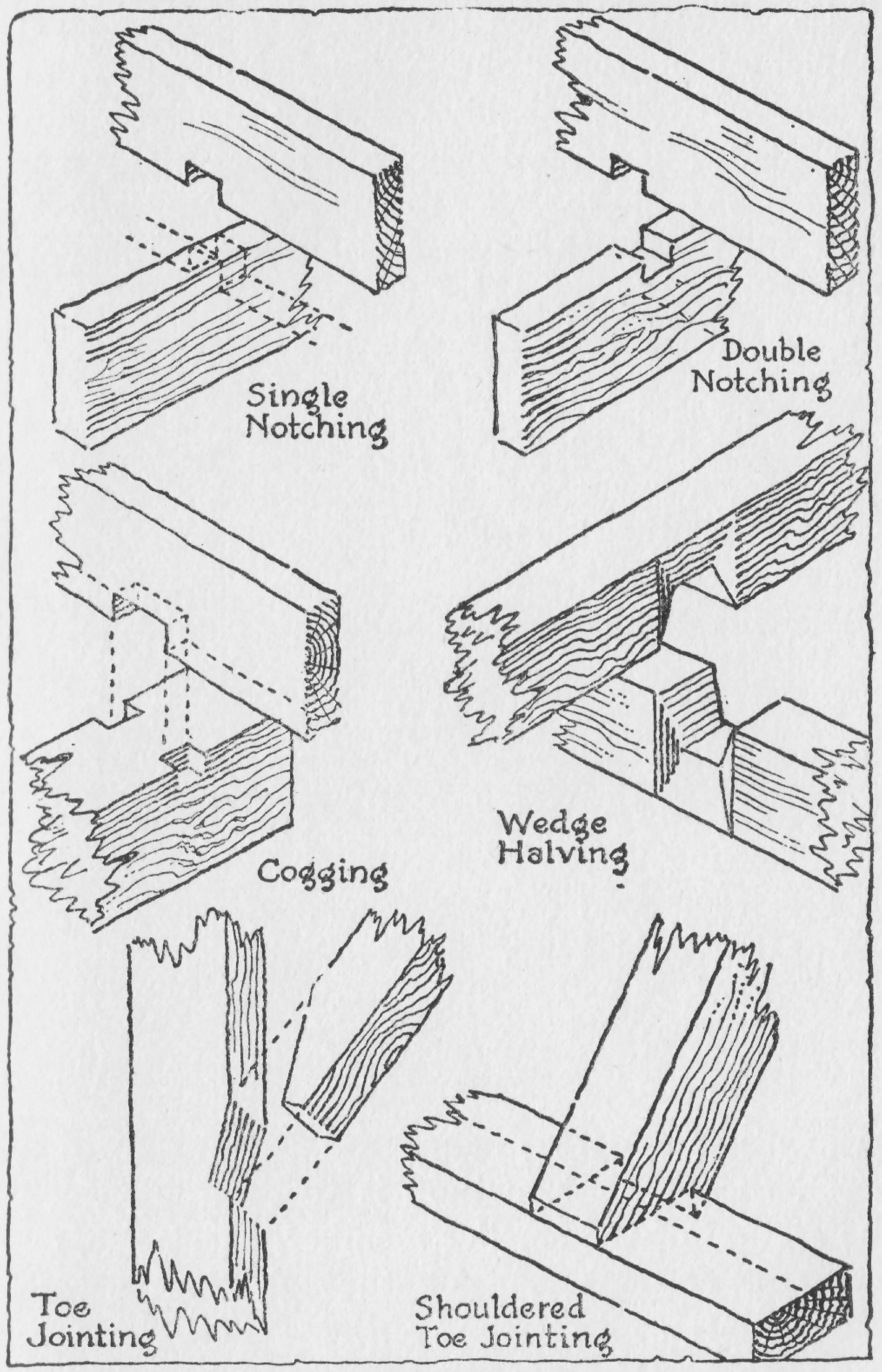

FIG. 11: Notching and toe jointing.

in the same plane the boards that form, for example, a table top. Shrinkage of the wood, however, even though slight, will open up the joints, so that one of several other joints is usually employed to secure together these long, thin surfaces. Dowel joints are those used in dining-table leaves. A dowel joint is formed by a wooden pin glued into one or both boards. In the case of the "extension" table, one end of the pin is left free. If the joint is a permanent one, the dowels are glued in both members and the edges glued together throughout their length, being allowed to dry while tightly clamped together.

Doweling. A doweled joint is a good joint, easy to make. The one difficulty it offers the beginner is that of getting the holes for the dowel pins exactly opposite one another. Clamping the two meeting edges side by side and uppermost, and marking across both together with the try-square, is a good enough way when the boards are of equal thickness. The holes are thereupon bored in the exact middle of each scoring. When the two members are not alike, and when only one pair of faces is to be brought into a plane (as frequently happens when a rail is doweled to a post), the simplest method is to draw in pencil the section of the smaller member, exact size, on paper or cardboard, prick through this the required centers into the end of the wood it matches, and then fit this stencil to the other member in

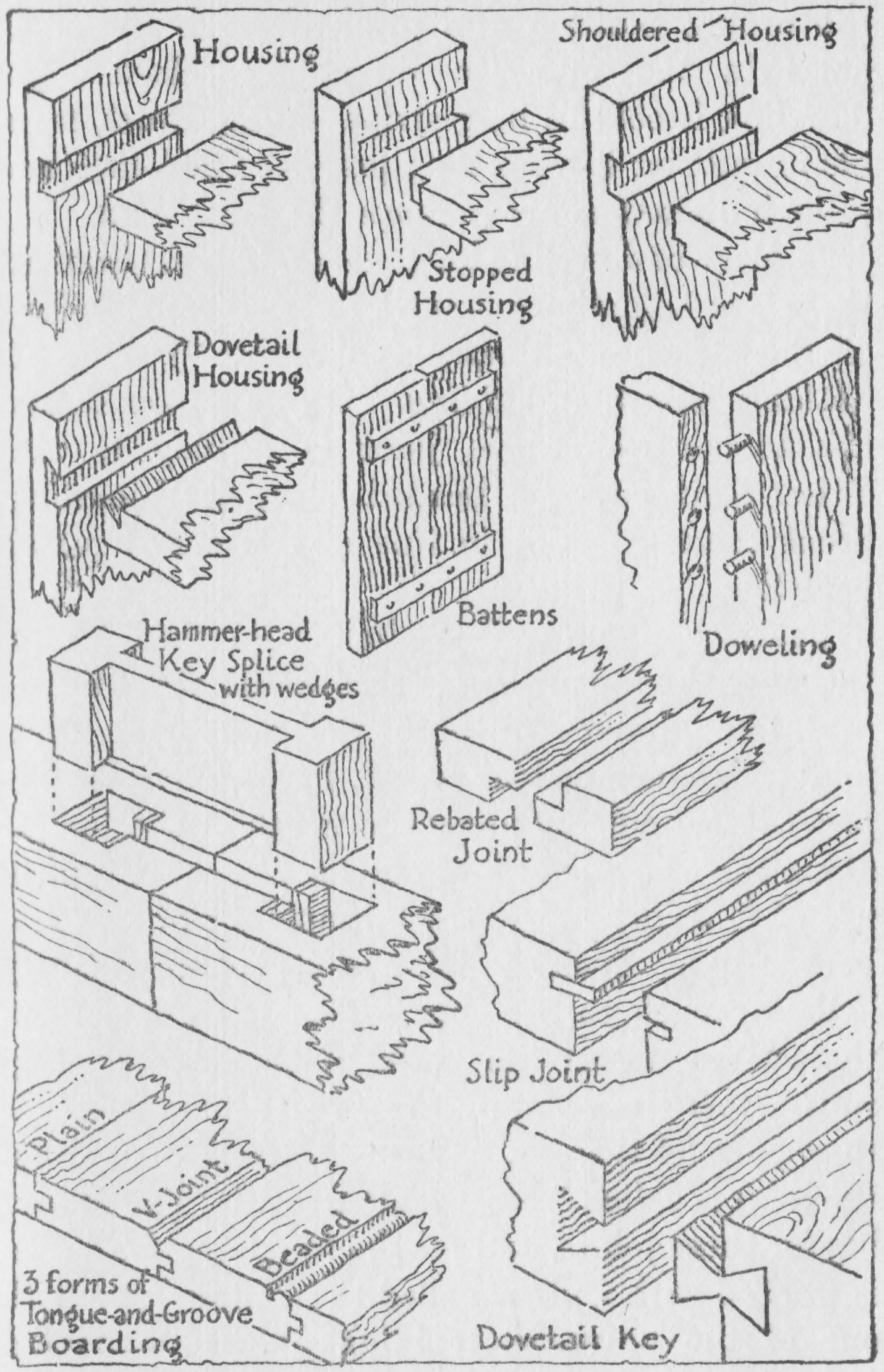

FIG. 12: **Housing**; **battens**; doweling; rebated, **slip**, **tongue-and-groove**, and dovetail key joints.

the proper position and prick through the same holes in the opposite direction. Hard-maple doweling is sold in long strips, saving much trouble in cutting it from the square. The $\frac{1}{4}$-inch and $\frac{5}{16}$-inch diameters are perhaps the most used.

In place of doweling long, narrow edges together, these are sometimes joined by a rebate (rolling off the carpenter's tongue as " rabbit "), which is nothing more than halving. Or, more commonly, the tongue-and-groove joint is employed, with either plain edges, a beaded edge, or V-jointing. Stock made to joint in this way is called match boarding.

Feather tonguing is a similar jointing, but in this case the tongue is a separate thin strip, fitting into like grooves in both the members. This joint is economical of wood, for it obviates the necessity of cutting away the width of the tongue along the whole length of one member. A typical use of it is in jointing thick maple members for a bench top. Such a joint adds comparatively little strength to the cohesion of the glued faces themselves unless the grain of the feather strip runs across the grain of the two members rather than parallel thereto. When the grain does cross, the joint is called " cross feathering." The grooving for these joints, and for the tongue-and-groove, is worked with a plane called the " plow ", or with one of the universal molding planes illustrated in back of book. Tongue is cut by rebating both

sides of an edge with this same universal plane or with a rebate plane Matching planes consist of a pair that rebate and plow for a tongue-and-groove joint.

The principle of the feather joint is carried a step further in the dovetail key joint, which opposes a lateral pull as well as the transverse one. It is a difficult joint to make, and is used only on heavy pieces.

For locking together the butt ends of timbers, in place of the splicing joints described above, a modification of the key joint is the hammer-head key.

Mortise and Tenon. The mortise and tenon furnish a whole family of excellent joints, suitable for a wide variety of uses. Simplest of all these forms is the open mortise and tenon, in which the tenon or tongue is the full width of the member bearing it, and the mortise is a mere slot in the other member, open on three sides.

Only slightly differing from this is the closed mortise and tenon, in which the third open side of the mortise slot has been closed.

The proportion of tenon thickness to the whole thickness of the member bearing it is usually about one third to one half. Nevertheless, it will be found a great convenience to fix this tenon thickness in conformity to the nearest convenient diameter of bit that will be used to bore its mortise. For example, in mortising two $1\frac{1}{8}$-inch boards, let

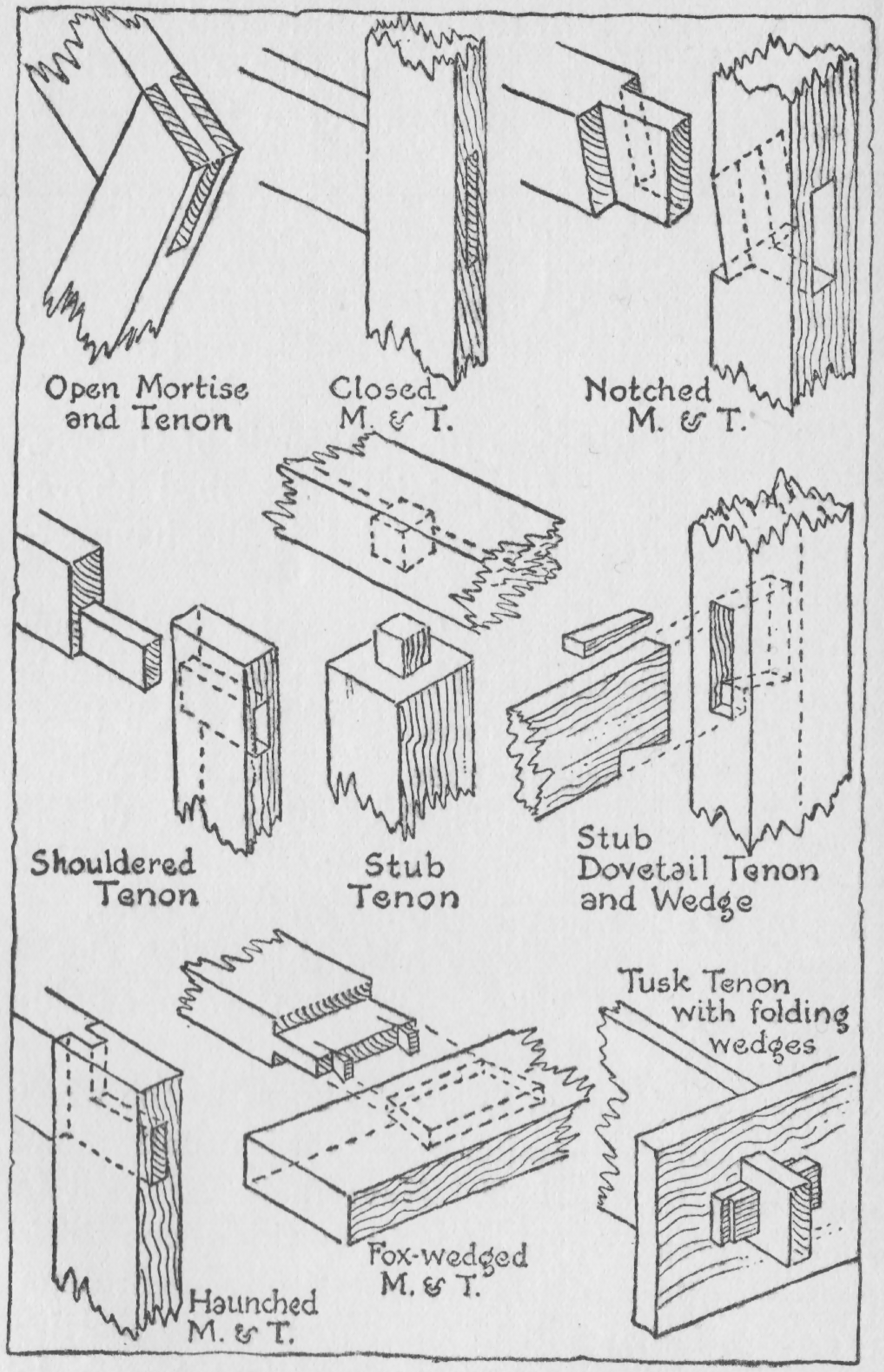

FIG. 13: Mortise-and-tenon joints.

us fix the tenon width at $\frac{1}{2}$ inch. The mortise is marked on the face to be cut by cross scorings with the try-square and by longitudinal side lines scored with the marking gauge (Figure 5). When the distance of either of these lines in from one face is set on the gauge, the scoring is done both for the mortise and, on the other piece, for the tenon, without resetting. A special mortise gauge is made with a pair of spurs instead of only one spur; and with such a gauge the two lines are scored simultaneously, being guided from the corresponding faces on both pieces. With the ordinary marking gauge, one line is marked on both pieces; the gauge is reset, allowing for the proper width; and the other side is then scored on both pieces. Hold the block against the faces that are finally to come into one plane. For the tenon, this scoring is done not only on the end grain but also on the two sides as far as the tenon's depth, where the lines meet the scoring that has been carried entirely around the member to indicate the shoulders.

The rectangle indicating the face of the mortise (Figure 14) having been marked, another line *C* is scored, bisecting this longitudinally to give a guide for the bit centers. At either end of this line, a point is pricked on the line and just half the diameter of the bit in from the end of the mortise. Bore these end holes through the mortise member, and continue to bore overlapping

holes, centering accurately on the middle guide line until the mortise is roughly bored out by holes inside of the scored rectangle and tangent to it. The finishing along the sides is easily completed with a broad chisel held with its flat side against the outside scored lines. For squaring the ends, take a $\frac{1}{4}$-inch chisel and, starting at the middle, push it straight down through the mortise with the flat side on the end scoring, as shown in the same diagram (Figure 14). The cutting is thus

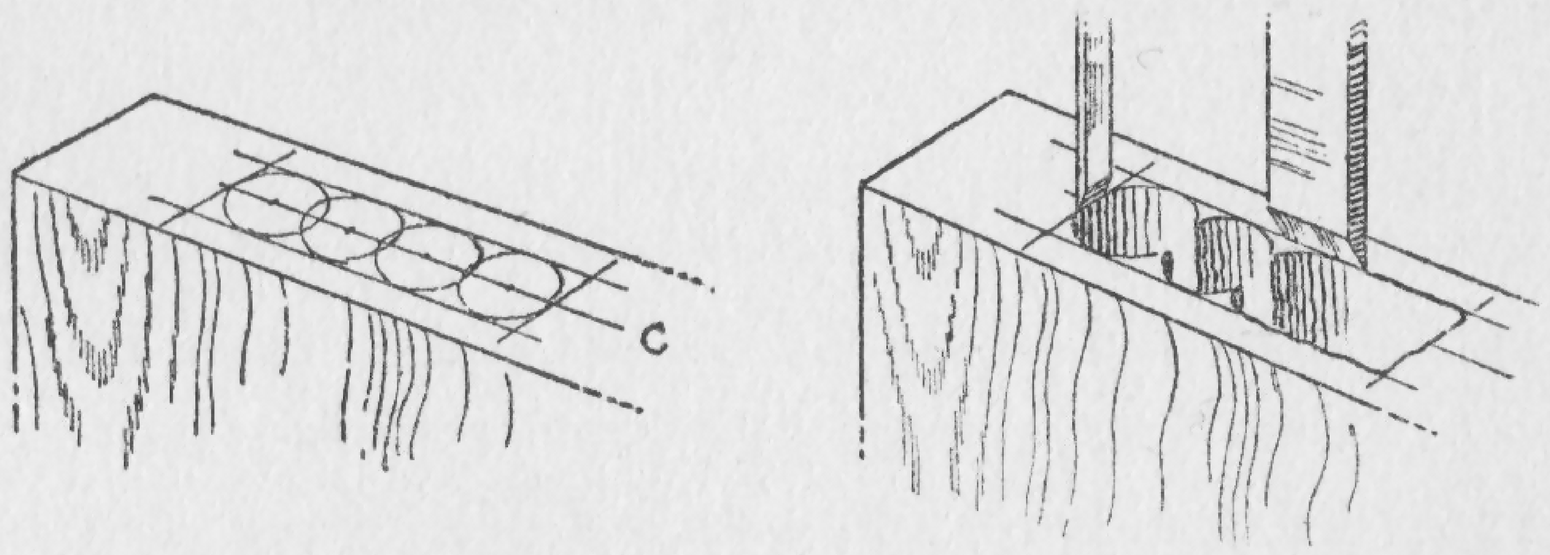

FIG. 14: At left, marking the outline of a mortise-face and establishing the centers for the auger. At right, a broad chisel removes the side waste after boring, and a quarter-inch chisel cuts out the corners, starting on the tangent.

done across both ends, chiefly with the outside corners of the blade. Continue this cutting by moving the chisel a trifle nearer one corner with each stroke. A final cut downwards, parallel with the longer dimension, completes the corner. Sawing out the waste flanking the tenon is a simple matter; but leave too much thickness rather than too little, paring it down afterwards to a snug fit.

To gain a better bearing for a tenoned member that will have to support weight, the closed tenon

joint is modified to what is called a "notched" tenon joint.

To gain strength where a tenoned member enters another at or near its end, a shouldered tenon joint is often used.

Thus far, in the mortise and tenon family, the tenon has in all cases been carried all the way through the mortised member. Stopping it short of that, we have the stub tenon joint. The mortise for this is made in just the same way as for a through tenon, excepting that the boring is stopped at the desired depth by means of the bit gauge.

Where a tenon must be prevented from pulling out, the dovetailed tenon joint is sometimes used, locked tight with a top wedge.

The haunched tenon joint is another solution of the problem of securing rigidity at the end of the mortised member. It is like the shouldered tenon joint, but cut back over only part of its length; either tends to preserve the full thickness of wood at the end of the mortised member (Figure 13).

An aptly named joint is the fox-wedged mortise and tenon — so called, perhaps, by reason of its clever design and the apparently inscrutable reason for its resistance against withdrawal. The diagram (Figure 13) shows it in its common form, but it is easily adaptable to a secret haunch form when the mortise comes at the end of the member bearing it. The tenon is cut in the ordinary way, but the mortise increases in length as

it nears its bottom, until it is as much longer than the tenon as the combined width of two small wedges that are to be inserted as shown. These wedges should be very narrow, or their splitting action will be fatal to the tenon itself. A saw kerf forms the slot for each wedge, carried to the depth of the latter. After the mortise and tenon have been glued, the wedges are started in their saw kerfs and the tenon is driven home. It will be seen that the wedges must penetrate to their full depth, else the shoulders will not meet the top of the mortise — and the foxiness of the joint will then impress itself upon the maker most forcefully, for it will be too late to withdraw the tenon for further adjustment. A very little spreading of the tenon is sufficient to grip the dovetailed mortise; so keep the wedges thin, and, as a further precaution, cut the tenon a bit shorter than the depth of the mortise.

Another scheme for holding the tenon firmly in its mortise is by pinning (Figure 15). One or two holes are bored through both cheeks of the mortise while the tenon is tightly cramped into place. A couple of pieces sawed off the mill-made doweling will serve if glued in place; but to get a really tight fit, it is customary to use instead a slightly tapered pin.

Drawboring was probably devised by some craftsman of long ago who bored for ordinary tenon pinning and then discovered that his two

members had not been tightly cramped together, and that the pinning now prevented their ever being made snug. It followed naturally enough that if he were to bore the mortise alone first, and then mark on the tenon, when inserted, the center point of the hole, he could bore the tenon hole very slightly nearer the shoulder than his center

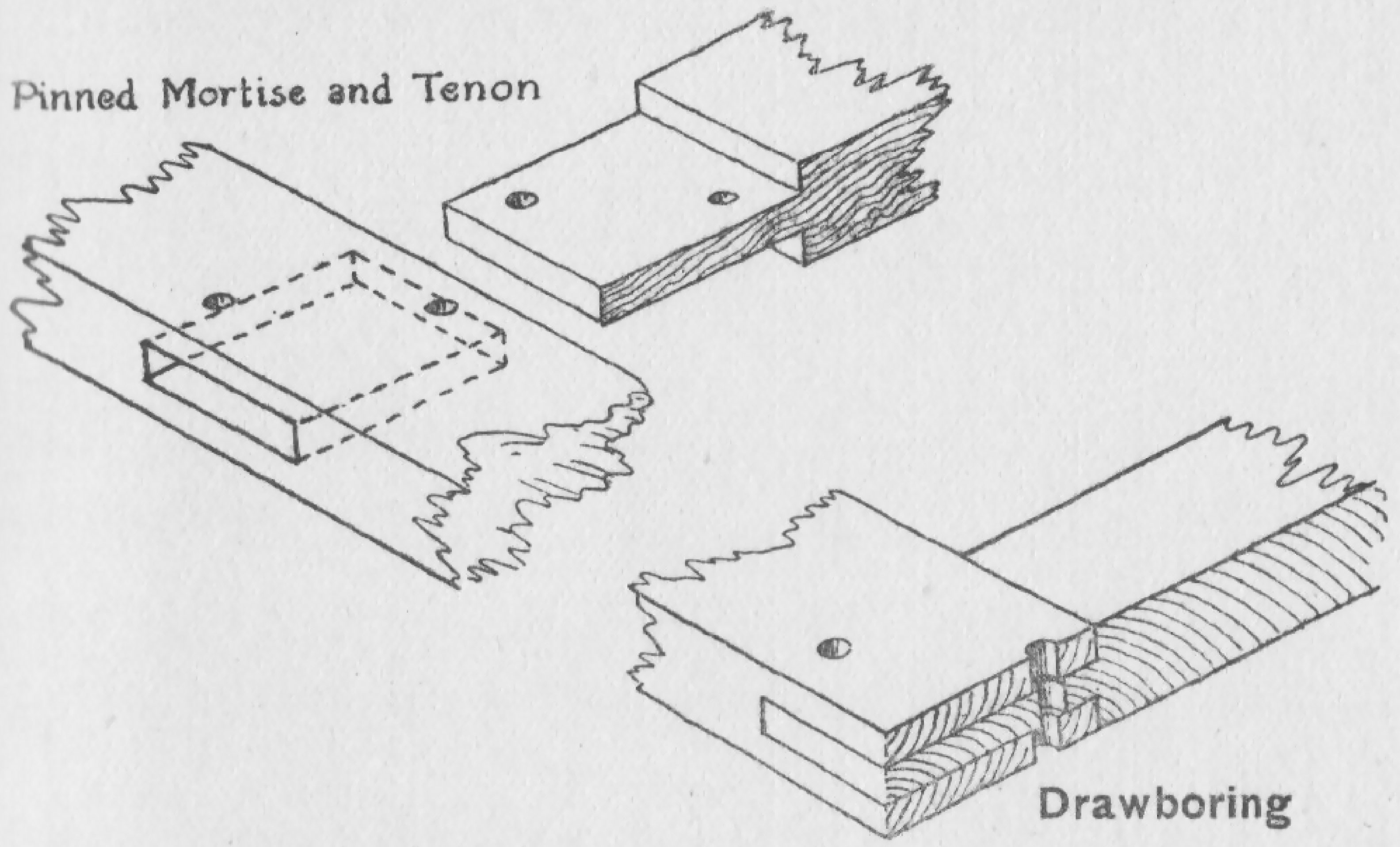

FIG. 15: The mortise-and-tenon joint is sometimes made more secure by pinning. When the holes in the tenon are slightly nearer the shoulder than are the corresponding holes in the mortise, the driving in of the tapered pin draws the two members snugly together.

point indicated (Figure 15). When this was done and the tenon put in place, a tapered hardwood pin driven through would draw the tenon in very snugly indeed. Here again, the tenon must be cut slightly shorter than the full depth of its mortise.

For a joint that may be taken apart readily when desired, the tusk tenon is used — differing from the ordinary tenon only in that it projects

far enough through its open mortise to permit of the use of a wedge or pair of wedges through a hole, to draw it snug. In cutting the hole for the wedges, put the tenon through and mark it close to the face beyond which it projects. Then cut the near side of the hole a trifle farther in than the mark indicates, to allow for drawing up.

The Miter. Miter jointing in its simplest form is well understood, yet there seems to be a common misconception that such a joint should be satisfactory just as its surfaces come from the saw in the miter box. That is why the amateur craftsman's attempts at picture framing usually leave so much to be desired.

The adjacent surfaces of a miter joint, having been sawed, should be planed to a perfectly true face, and this can be done only on some such form of shooting board as is shown in Figure 7. Professional framers usually do this surfacing with a heavy pivoted cutter, not unlike the trimming board used for photographs.

With smooth and true surfaces, the picture framer usually depends merely upon a glued joint reënforced by a brad or two; or in heavier frames, upon a piece of crimped sheet metal with a sharpened edge, which is driven into the two members from the back, crossing the miter. The cabinet-maker, however, scorns such frailty in the heavier miter joints called for in his work and secures the miter in one of several ways.

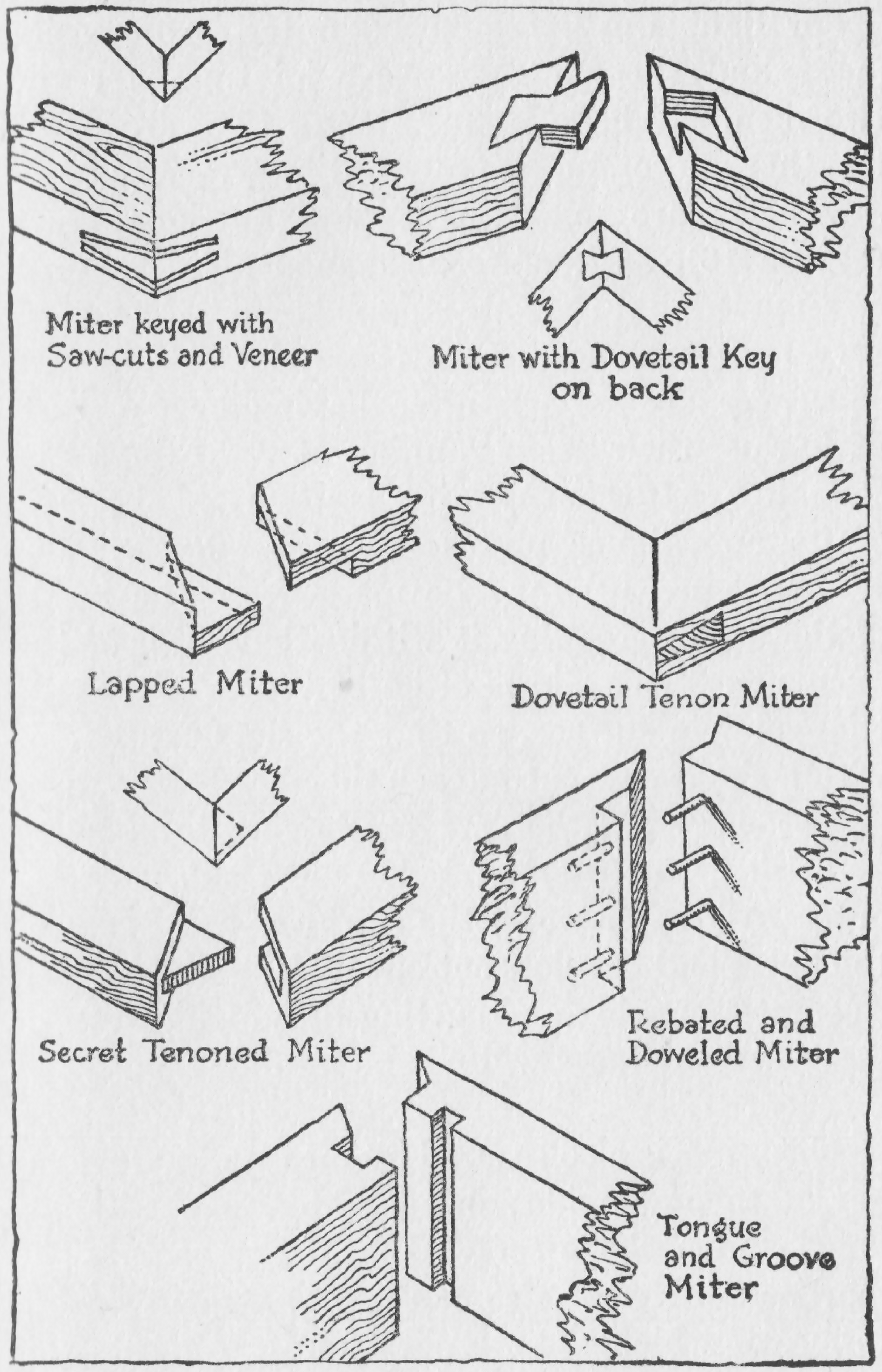

FIG. 16: Miter joints.

For light work, the keyed miter is an easily made and surprisingly strong joint. After the two members have been mitered, they are glued together and cramped truly until dry. Then two saw kerfs are made across the outside corner (Figure 16), as if a wedge-shaped piece were to be removed, but they are stopped before they come very near together. Into these slots two pieces of veneer are forced, after having been coated with glue, their grain running at right angles to the miter. If this key miter is unsuitable because of its appearance on the outside edges, a slip joint (Figure 12) may be made from the inside of the angle, stopping it within the width of the members. This slip is often of veneer and made triangular in surface, so that the slots can be cut with a single saw-cut in each member before these are brought together. After having been glued and dried, the interior angle of the slip is sawed out. In heavier work, the slip may be of greater thickness and the slots cut out with saw and chisel. Accurate marking and cutting are obviously necessary, or the faces will not be in alignment when finished.

The miter is also secured by means of a dovetail key on the underside; or again, by a lapped joint, glued and perhaps screwed from the back. The mortise and tenon also can be adapted in several forms, of which the strongest and the most difficult to make is the dovetailed tenon, either carried

through or stopped. Doweling is applicable in miter jointing, just as it is used for reënforcing any butt jointing of comparatively narrow surfaces. The dowel holes are at right angles to the miter, and must be kept near enough to the inside corner to make sure that they will not cut through to the outside faces.

If the mitered surfaces are of greater length than in a frame (as, for example, at the junction of front and end of a chest, where the miter is used to avoid showing end grain), a rebated miter joint may be used, further strengthened by doweling along the rebate edge. Or the rebated portion of the joint may be replaced with tongue and groove.

The Dovetail. Dovetailing is one of the joints most used in fine cabinetmaking for joining the edges of two boards at right angles where the chief strain to be met is a pulling apart. The joint has almost the full strength of continuous wood, but this is secured only at the price of considerable labor and well-nigh perfect workmanship. A joint very commonly used in box-making, and achieved by machine cutting, is a continuous form of open mortise and tenon at the angle, called the "box pin joint." It is often loosely termed dovetailing, but the latter name belongs properly to a joint having a fan-tailed tenon and a corresponding mortise. It will be readily seen that the dovetail can be applied to halving, notch-

ing, and mitering, and its basic principle is employed in the fox-wedged joint above described.

The open dovetail is merely a modified open mortise-and-tenon joint, but it resists separation

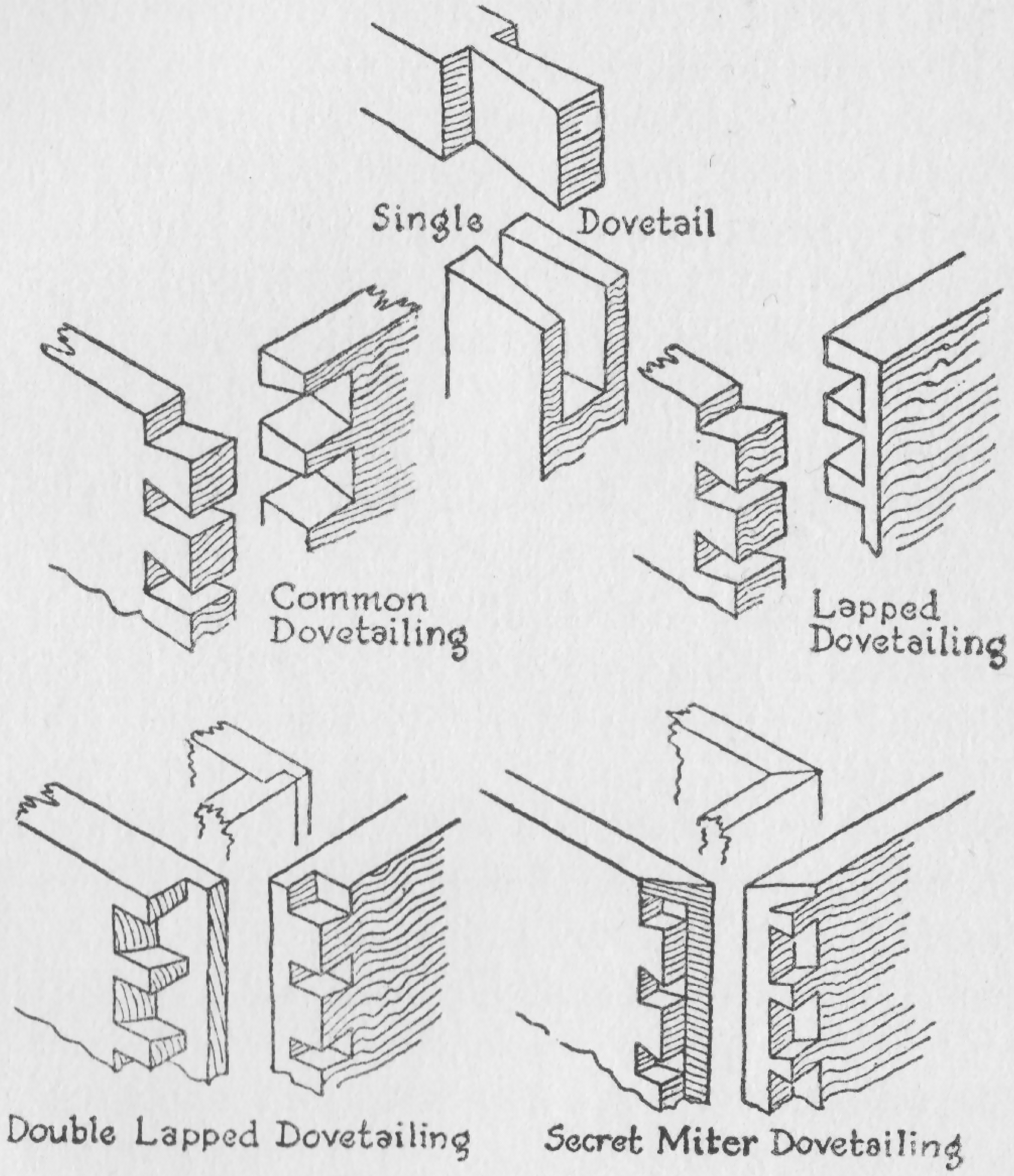

FIG. 17: Dovetail joints.

in every direction but one — the one from which the tenon is inserted; and even this single exit may be locked by gluing or pinning or both.

Common dovetailing is this joint prolonged in successive adjacent units. Lapped dovetailing goes one step farther toward concealment. Double lapped dovetailing hides the dovetailing proper but shows a lap of end grain. Secret miter dovetailing goes a step farther and gives the ideal corner joint, showing no end grain nor any external evidence of the precise and strong interlocking of the two members. The man who achieves it in perfection need not question his right to the title of craftsman woodworker.

To mark out a pair of members for common dovetailing seems a bit complicated until one knows the few simple steps that achieve a given number of pins and sockets, evenly spaced along the length of the joint. Every experienced woodworker has his preference for the order of cutting — whether pins first or sockets first — and will bring forward cogent reasons for his choice. Without apology, therefore, I shall take my stand with the "sockets first" contingent, chiefly because I find it easier to mark pins from the finished socket member than to work the other way about. To the uninitiated, the difference between a pin and a socket is not readily apparent. Strictly speaking, both members have projecting wedge-shaped tenons at their greatest depth. It is customary, however, to make the tenons on one member decidedly narrower than those on the other — usually about one third the width

at the wide end; and the narrower tenons are called the pins, whereas the corresponding wedge-shaped slots on the other member, into which the pins fit, are called the sockets.

To mark out a set of sockets, let us assume that we are making a drawer $9\frac{1}{2}$ inches deep outside. Since the dovetail must be arranged to withstand separation when the drawer is pulled out, the pins will be on the front member and the sockets in the side piece. A glance at the diagram (Figure 17) will show clearly that the pieces would easily disengage if cut in the reverse manner.

After the ends have been planed smooth and exactly at right angles to the length, the first step is to decide upon the number of pins to be used. The thickness of these will depend upon the thickness of the stuff and also upon its character; pins in soft wood are made wider than in hard wood. Roughly, for hard wood, the thickness on the wider face of pins may be about three quarters of the thickness of the wood. The distance from center to center of pins will be more than twice their width but less than three times that. The front and side pieces of our drawer are $\frac{7}{8}$ inch thick. Let us assume the width of pins to be $\frac{5}{8}$ inch. Assuming the distance between centers to be $2\frac{1}{2}$ times this, or $1\frac{9}{16}$ inches, we divide this into our length of joint ($9\frac{1}{2}$ inches) and find it goes about six times. Now, since we have a half pin at each end, and six spaces, center to

center, we shall have five full pins and at each end a half pin over.

A pin exactly half thickness is usually too thin for safe working, so let us allow an extra $\frac{1}{8}$ inch at each end to thicken these two half pins. Pencil two lines, each $\frac{1}{8}$ inch in from the outside edges of the drawer side (Figure 18), representing the centers of our end sockets. Scribe the depth of the pins around the joint end — it will, of course, be the thickness of the drawer front, $\frac{7}{8}$ inch. Now, we wish to divide the space between the penciled center lines into six even spaces. Here is where our old school friend, Plane Geometry, comes to the rescue with the theorem that says, "If three or more parallel lines intercept equal parts on one transversal, they intercept equal parts on every transversal."

In the practical application of the theorem, we lay our rule diagonally across the space between the penciled guide lines until this diagonal length is readily divisible by six, and point off the six spaces (Figure 18, A). Then, with a try-square held on the joint end of the board, we can carry down our parallel lines to mark the pin locations. Figure 18 will make this clear. Since we are marking sockets, the edge of the board will be marked with the pin width at its narrowest or deepest point. This is seldom made less than $\frac{1}{4}$ inch; suppose we mark it as $\frac{5}{16}$ inch, and, at the depth of the socket, mark $\frac{5}{8}$ inch, centering each

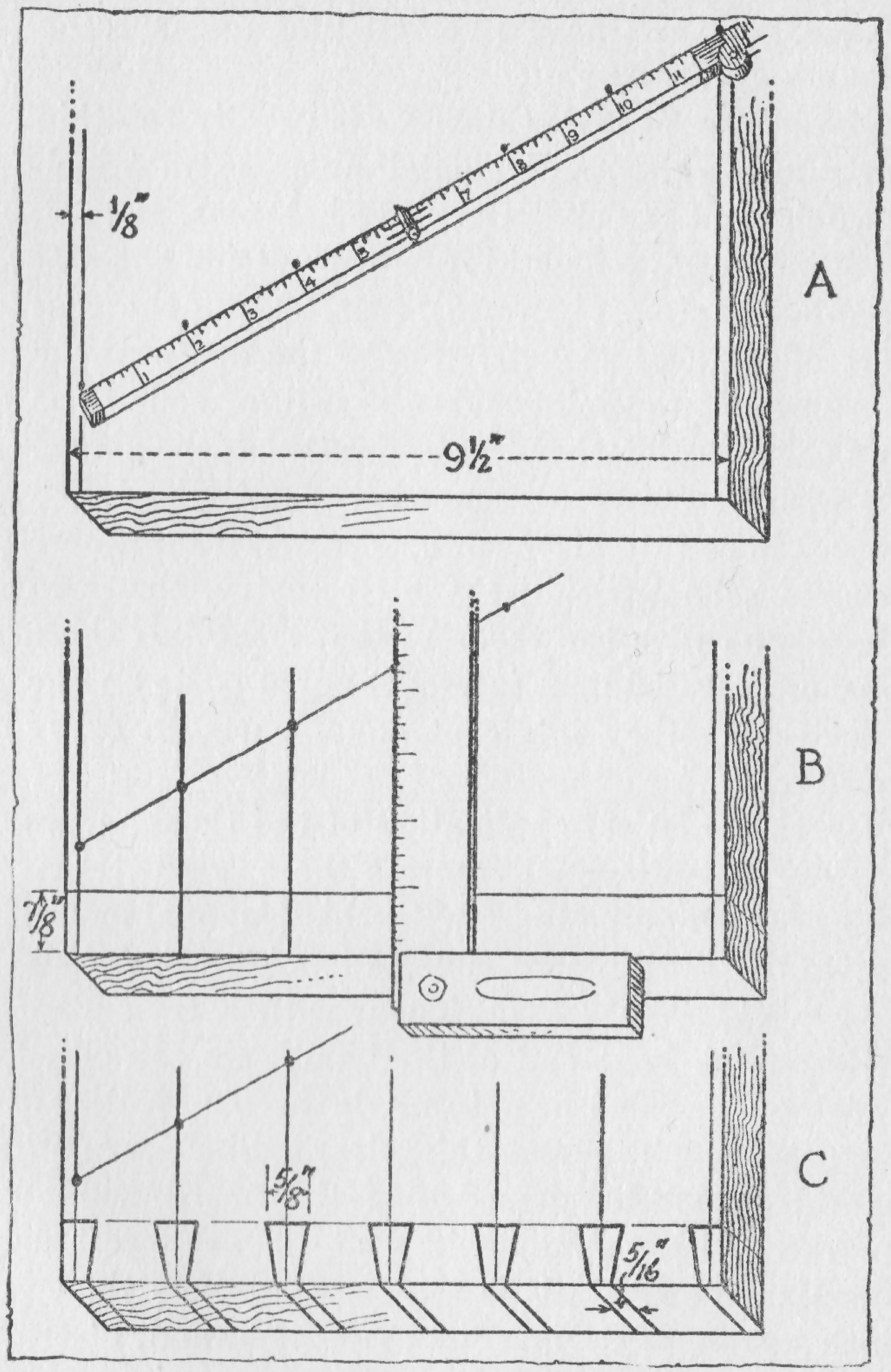

FIG. 18: The three steps in marking out sockets for a dovetail joint between the front and side of a drawer.

of these accurately on our center guide lines drawn in pencil. Scribe the connecting lines between joint edge and the back line, using a bevel for this purpose. Set the bevel by one pair of marks, test it on one or two other pairs, and then scribe all of the lines representing one side of the sockets. Turn the bevel over to get the reverse angle and complete the scribing of the other sides. It is well to scribe the ends of the board with the socket widths by means of the try-square, and repeat the bevel scribings on the other side. Only the most expert craftsmen can trust their eyes to carry the saw-cuts through accurately from the one scribing.

The sockets being fully marked, the portions to be cut away are marked with an "x"; the drawer-side is clamped in the vise, joint end projecting above the top, and the sockets are sawn down to the back guide line. A tenon saw or backsaw will be used, except by such experienced workers as prefer the quicker action of a ripsaw. The saw-cuts must be made on the waste side of each scribing. Start the saw-cut on the near corner, bringing the saw gradually to the horizontal position as it nears the end of the cut. All the bevel saw-cuts having been made, the waste can be removed by chiseling, or by boring and chiseling, or by the combination of coping saw and chisel. The finishing to the exact line of the depth-scribing is best done with a very

sharp chisel. Work halfway in from one face, then turn the board and complete the work from the other side. If the saw-cuts have kept too wide of their marks, pare down the sides of the sockets as well.

With the socket member fully cut, place it on the pin member, *i.e.*, the front of the drawer, and scribe the pins from the sockets. Carry back the side lines with the try-square until they meet the back line representing the full thickness of the drawer side; and, after marking the waste portions with the " x ", saw down the sides of the pins and remove the waste as before.

The methods of making a lapped dovetail joint, a double lapped dovetail, and a secret miter dovetail are in the main similar to the method described above. In the lapped joint, the chisel will have to do much of the work that the saw performed in the simple dovetail; and the depth of the sockets as scribed on the drawer side will be less than the thickness of the front stuff by the thickness of the lap (Figure 17).

In the double lapped (or secret lapped) dovetail, the socket member as well as the pin member will have to be chiseled, rather than sawn, to remove the waste. Since with this joint it is inconvenient to mark pins from the cut sockets, the pins are cut first.

The secret miter dovetail is made with overlapping square edges on both members like those

on the socket member of the double lapped dovetail, and this lap is planed down to a miter either before or after the pins and sockets are cut. For this work there will be needed a plane with its cutting bit coming all the way to one edge — such as a rebate plane. The remaining bits of mitering at the ends are cut with the chisel.

CHAPTER VIII

Exterior Painting

TRADITIONS die hard. From earliest boyhood I had heard the knowing ones say, "When it comes to paint, there's nothing to touch good old lead and oil." I hear it still, even from experienced painters. The architect's specifications laid great stress on the simple formula, and, for all I know, still do.

Like many similarly well-rooted beliefs, it is only a half truth. There is no doubt that white lead and linseed oil are two essentials of paint; that without either of them we cannot have good paint. It is also true, however, that the best paint contains other ingredients. More important is the fact that no man can take a pot of white lead and mix it with linseed oil, turpentine, and drier to make a paint that is as good as he can buy ready-mixed.

For years I tried to do that very thing in the fond thought that I should get better results. It does not work. Sometimes the job would not dry. I tried adding still more japan drier, only

to find that I made matters worse instead of better — too much drier will prevent the very action that drier is designed to bring about. Inquiry among practical painters brought only the rule: "Add 'a little' drier to the mixture." No one seemed to have worked out a rule for a measurable formula. Again, the job would have a stringy appearance when dry; the paint not having been thin enough to spread properly. At other times, it would be partly glossy, partly flat. It was always a gamble, frequently resulting in a job that had to be scraped off or washed down with benzine to get a fresh start.

The truth of it is that the composition of paint is a highly technical matter, permitting only a very narrow measure of variation from the normal. Paint is no easier to make without real knowledge and tested ingredients than are many of the prescriptions that we would not think of taking out of the skilled hands and laboratory of the pharmacist.

Undoubtedly one of the chief reasons for the persistence with which the old tradition of "lead and oil" is maintained is a lack of frankness on the part of the paint manufacturers. They have not told the public of the importance of other ingredients because of the fact that the very things that add to a paint's worth happen to be the ingredients which unscrupulous manufacturers add in too great quantity as substitutes for the

necessary lead and oil. Apparently the conscientious paint makers feared that if they acknowledged using these other ingredients at all they would be open to the suspicion of deleterious substitution.

White lead in oil for exterior use needs the addition of zinc oxide and of some such inert reënforcing pigment as barytes, silex, asbestine, or china clay. It needs the addition of turpentine to make it flow better from the brush. It needs a proper amount of a drier. These ingredients cannot be so thoroughly blended by hand as they can by powerful grinding machinery. They cannot be assembled by rule of thumb in a paint pot as well as they can be united by mixing machinery. It is a waste of time and money, with an assured sacrifice of quality, to attempt it.

It by no means follows, however, that ready-mixed paint, as it comes in the can, is the best mixture to use in all places and under all conditions. Otherwise, this chapter might begin and end with the advice to buy ready-mixed paint and put it on. The problem is not so simple as that, but it is greatly simplified by starting with the best that a reputable maker puts out, and modifying this paint to meet individual conditions.

New Woodwork. Take, to begin with, the painting of new woodwork. The first essential is that the wood be dry. A wood that is apparently dry on the surface may have absorbed a

great deal of water from recent rains. This inside moisture must have a chance to find its way to the surface and be completely evaporated, else it will later cause peeling or blistering of the painted surface. Moreover, the wood must be free from surface grease, one of paint's greatest enemies. Finally, wood when warm will take paint better than when it is not.

Wood that is green and sappy cannot be well painted in that condition. Time and weathering will help slowly; but if the job has to be done before the sap has dried out, the wood should be shellacked first. Knots and sappy streaks will surely make their presence evident through paint unless they are shellacked. In these days of imperfect seasoning, when green lumber is rushed through from the tree to the building, the shellacking of such knots and streaks has come to be a most important preliminary to priming. Nevertheless, it should be remembered that a coat of shellac under paint keeps the paint from getting the penetrating hold upon the wood that is an essential of the best results. If the wood as a whole seems sappy, and yet must be painted before it is seasoned, add to the paint as it comes from the can a pint or so of turpentine to the gallon.

If, on the other hand, the wood is old and dry — fairly thirsting for paint, add to the gallon of normal paint a quart, or even more, of linseed oil.

Redwood siding, sometimes sold as cedar, offers

special difficulties to a first painting. A coating of linseed oil in which a small amount of pigment is stirred, with the idea of showing just what has been covered, will protect the surface while it weathers for at least three months. After that, it is safe to paint it in the regular way.

The first coat, or priming coat, is the most important of the three that will ordinarily be required. Brush it in well. If you have ever noticed an expert painter, you will have been impressed by the vigor and force with which he wields the brush. That characteristic slap of the brush as he starts a stroke is not mere exuberance of spirits. He has learned the important fact that to put a good coat of paint on a surface, he must get every bit of it in close contact. Merely smearing the paint on by dragging the brush over the surface leaves a thin layer of air between it and the wood. Brushing it vigorously on, with the characteristic slap, forces out that air and leaves the paint in contact, where it will stay — provided only that the surface is right and the paint is of the proper mixture to get into the pores of the wood and hold fast.

Another detail that you may have noticed in the experienced painter's work is that he uses a heavy brush. The reason is twofold. A heavy brush gives him greater force of application, and it holds more paint. A thick brush is the proper form for exterior paint, just as a flat brush is better adapted to varnish, and a wider flat brush to interior wall surfaces. The size of the thick brush will, of course, have to vary with the requirements of the job. A fairly small one makes neater work on window-sash muntins and along narrow moldings — in the hands of the amateur, at least. In the old days, a painter had not mastered his trade until he could paint a sash with a "pound" brush. A smaller size marked the wielder as a novice. Whatever its size, the trained painter will use the brush without revolving it, so that he soon works the brush to a chisel edge rather than a point. Once the edge has been worked to this form, it is astonishing how closely one can follow the edge of a narrow member even with a large brush.

Allow at least three days for the priming coat to dry thoroughly. Green wood will need even more, and some weathering will improve its condition for the second coat. If a good, smooth, finished job is desired, sandpaper the surface when it is perfectly dry, taking off the tops of the tiny bubbles that may have formed, and removing and smoothing up the channels left by stray bristles. This is the proper time to do any puttying that may be needed to fill nail holes and cracks. A very little white lead — or, in the absence of that, white paint — will lighten the putty color and make it easier to cover this up with the remaining two coats.

For the second coat, the addition of a little turpentine to the normal paint will usually be advisable, excepting in the case of very soft wood, where oil instead will again be needed in excess, though not in so great quantity as for the first coat. If the priming coat when dry shows any trace of gloss, no further addition of oil is needed. If it dries flat, add both oil and a little turpentine, for the wood is still thirsty.

Allow three days for drying and, after a light sandpapering with worn paper, apply the third coat of paint as it comes from the can.

Old Woodwork. The repainting of old woodwork brings additional difficulties if the former painted surface has peeled, cracked, or powdered. Badly peeled work will never be brought back to a good surface without scraping the old paint down to the wood. A wire brush will smooth old paint and give it a better tooth to hold fresh paint, but the wire brush will not, without excessive labor, do the work that a steel scraper will do. This scraper is nothing but a flat plate of polished steel, about three by five inches and something less than a sixteenth of an inch thick, but it has an uncanny degree of efficiency in plowing off paint. It is pushed along between thumb and fingers, forward and back, at an angle of about thirty degrees to the surface, a sideward cutting motion being combined with the forward stroke. If the paint is not readily removed in

this way, soften it with prepared paint remover and scrape it immediately afterwards.

The painter's torch is an effective means of removing outside paint from plane surfaces; on moldings and such work the paint remover and specially formed scrapers are easier to employ. The torch is so often misused, even by supposedly expert painters, that a word of caution is needed. The point of the flame is the hottest part, and it should just touch the surface. Immediately this starts to soften, the flame is moved on to the left, with the torch in the left hand, followed by the scraper held in the right. The paint should not be allowed to burn; it should merely be heated enough to soften it, else the wood itself will be charred; and charred wood will not take paint. The scraper is pushed forward with a slanting, cutting motion, rather than used merely as a plow. Keep it sharp. If flame and scraper do not take the whole layer off to the wood, the occasional thin remainder may be very lightly touched by the flame on a second trial and scraped clean. If the paint does kindle into flame, the following scraper instantly smothers it. And if the wood chars in spite of precautions, wire-brush it until the surface shows clean fibers before repainting.

If the old painted surface is unbroken but seems dry and powdery, add a quart or so of oil to the gallon of normal paint in the first coat. If it

seems hard and brittle, add turpentine instead of the oil — a pint or less to the gallon.

Home Mixing. For those who have a stock of the raw materials on hand, or who for other reasons prefer to mix their own paint, here is a priming coat for outside woodwork:

White lead	4 to 6 pounds
Linseed oil	1 gallon
Turpentine	1 pint
Japan drier	1 ounce

It is best to take a clean pail and pour into it first a little oil to keep the lead from sticking to the dry bottom. Pour the turpentine into the linseed oil in a separate receptacle. Put in a little of the lead with a wooden paddle, and more of the oils, and work up the mixture. Gradually add the rest of the lead and of the oils, working the lead into solution with the paddle. If the paint is not to be used until another day, withhold the drier until the last moment. The lead and oils will be better for standing a day or so to become more thoroughly mixed.

For a second coat, mix equal parts of linseed oil and turpentine, and work in enough lead to secure the right consistency — a thick cream. If the turpentine is below sixty degrees, the paint should weigh about sixteen pounds to the gallon; if warmer, eighteen pounds to the gallon. Notice

that no drier is needed, the excess of turpentine sufficing for the purpose.

For a third or final coat, use all linseed oil, or half a pint of turpentine to the gallon of oil, work in the lead as before, and add an ounce of japan drier.

If color is to be added, work up a little ground color in oil and add it to the mixture while this is still a rather thick pudding-like mass; the color is likely to float on the top of a thinner paint, making its incorporation with the paint more difficult. It is unnecessary to use the color in the priming coat.

All paint mixed by hand will need, before it is used, to be strained through doubled cheese cloth. A brush is employed to help the paint through the strainer, which may be tied tightly over the top of the pail.

It is an interesting fact to remember that for a gloss finish, such as is usually sought on outside work, the best results follow a second coat drying flat, of the sort obtained with the mixture described above. On the other hand, when a flat finish is sought, the next coat below should be glossy. For some obscure reason, a gloss finish is not so glossy over a gloss coat next below, nor a flat finish so evenly flat and smooth when a flat coat is just underneath it. In this connection it may be well to mention the rather well-known fact that a marked excess of oil over turpentine

gives a glossy surface, whereas a flat finish requires an excess of turpentine over oil. For a dead flat finish, the lead should be thinned with turpentine alone.

Another point to remember is that a mixture of white lead and oil tends to become yellow when used inside. Outdoors, this tendency is offset by the natural bleaching power of the sun and air.

Metalwork. Exterior metalwork — iron, steel, or tin — is best covered with one of the special paints made for that purpose. Its surface, if not before painted, is likely to need special care to free it from scale, grease, and moisture. When warm, it takes paint better than when chilled. Galvanized iron, in rain gutters and leaders, is particularly likely to be greasy when new. Weathering will improve the surface for painting; but if the painting must be done at once, wash the surface with a mild acid, such as vinegar (preferably hot), and allow it to dry thoroughly before the metallic paint is applied. After this priming coat of special paint on metals, the ordinary paint used for exterior work will serve as well as anything else.

Masonry. Stone, brick, and cement do not so often give occasion for painting as do the more familiar wood and metal surfaces; but since less is known of the proper procedure in connection with them, they must not be overlooked here. Thorough dryness of surface is difficult to catch,

for masonry walls will soak up a greater amount of moisture in a rainy day than will ordinarily be evaporated from the surface in a week. It is a matter of watching for a favorable opportunity, for the evaporation process cannot be hurried, nor is it possible to keep paint on against the pull of the sun upon that water inside. On cement surfaces, loose particles of sand offer a real source of trouble; but stiff brushing down with a broom or wire brush will remove most of them. Do not attempt the painting of concrete or cement until the setting process is complete; six or eight months are required before painting is safe. In cases in which earlier action is necessary, the brushing on of strong zinc sulphate solution will hasten the surface changes that are necessary before danger of peeling is past; but this is a makeshift at best. Special paints, made for the purpose, are available and should be used on these masonry surfaces.

Colors. Any discussion of colors for exterior work would be outside the scope of this book. I cannot, however, refrain from suggesting that the growing use of whites, soft greens, grays, and browns has abundant justification in their harmony with the predominant colors of nature. It is not always possible to buy the exact shade of paint that is wanted, but it is an extremely simple matter to alter the available mixtures. Pure ground colors are obtainable in very small cans.

With white lead, lampblack, burnt sienna, Prussian blue, and yellow ocher, one has at hand a palette that, though not covering a wide color range, makes possible most of the desired modifications upon the ready-mixed colors suggested above. In adding any of these pure colors to a can of paint, it is well to take a little color from its can on a putty knife and thoroughly dissolve it in half a cupful of the paint before stirring it into the paint can. A very, very little of this pure color (except in the case of white) will have a surprisingly marked effect on the basic mixture. Work in the direction of darker colors rather than towards lighter modifications, for so much white lead is required to lighten a can of dark paint that the proper mixture of pigments is likely to be upset.

Care of Brushes. A word as to the care of brushes. It would be interesting to consider authoritative data on the consumption of brushes among amateurs, if such data could be had. These would probably show that, if placed end to end, the brushes used in one year would reach to Betelgeuse and halfway back. "Consumed" is not the proper word; "ruined" is more nearly accurate. There is a painting job to be done; paint and a brush or two are bought; the job is finished; the brushes are laid neatly across the top of the nearly empty can — unless they are left in the paint; and the can is stored away in

the cellar, attic, or barn. A month or so later, the next painting job appears on the horizon. More paint is bought; so are more brushes, for "the ones we have are really not fit to use."

It must be admitted, however, that in most cases the brushes were not worth preserving.

A paintbrush from the "five-and-ten"
A simple paintbrush was — and, then,
It could be nothing more.

We have arraigned those little black, tin-bound, flat brushes, however, and have found them wanting. If, perchance, the home craftsman may be induced by these words to make a real investment in brushes, he not only will find painting a craft worthy of his effort, but will also have enough self-interest, if not self-respect, to give these brushes proper care. Good brushes are expensive tools, but they are no more expensive than is a succession of poor brushes used once and then discarded.

After use, scrape all the paint out of the bristles with the edge of a shingle or a thin board, resting the edge of the brush on a newspaper. Fill a jelly tumbler with benzine and work the rest of the paint out in that. Finally, wash the brush in soapy water, preferably hot, and, after thoroughly rinsing it and shaking it out, wrap it with others in a soft cloth and lay it on a shelf.

If, at the end of a day, the painting operation

has to be suspended, scrape the excess paint back into the can and lay the brush in a tray containing water enough to cover the bristles. Do not stand the brush on its edge, as this destroys its shape. In the morning, scrape the brush out under a good pressure, using a flat board; wash the brush in benzine; shake it out; and work it full of paint once more.

If you have several brushes that are decrepit and useless with an accumulation of old paint, you can buy from a supply house a strong solvent that, when dissolved in water according to directions, will clean all but the hopeless wrecks. After using the strong solvent, wash the brushes thoroughly in hot, soapy water; then rinse them thoroughly in water, and finally in benzine, to remove any last trace of alkali.

Supplies. In all the foregoing operations, it will be noticed that there is frequent need of linseed oil, turpentine, and benzine. When we come to the matter of varnishes, denatured alcohol will also be required. It is essential to have these materials on hand at all times, particularly as there is no spoilage or waste in so doing. A convenient way to keep them is to get four ordinary kerosene cans of a gallon capacity — the sort that has a screw cap and a spout. Paint the outside of the cans, preventing unsightly rust, and letter each with the name of its contents. When the contents run low, it is an easy thing to carry

the can by its handle to the supply house and have it refilled.

The keeping of left-over quantities of paint is another real economy. If left in a nearly empty can, paint soon becomes unfit for use. Keeping it away from the air is the only way to save it, and this is easily done by pouring the remainder into jelly tumblers or larger glass jars that can be filled practically full and capped tightly. Incidentally, the glass makes the identification of colors easy.

Putty is another staple for which one always finds unexpected use, and which can be kept on hand. Buy it in the pound tins, with a tight-fitting lid. It soon becomes hard, even when kept closed; but a few digs into the mass with a putty knife, and just a few drops of linseed oil worked in, will soften it for use. In case it is too soft to work well, which is likely to be the case in warm weather, the addition of a little whiting will bring it to the proper consistency.

CHAPTER IX

Interior Painting

The painting of inside woodwork, plastered walls, and floors brings an entirely new set of conditions. Outdoors, the chief consideration is protection. Paint must shield its covered surfaces from the constant attacks of rain and sun. Indoors, on the other hand, the chief purpose is color and surface texture. Here our concern is not so much that the pores of the wood shall be filled, the pigments cover, and the oils bind the whole together in a gripping and durable coating. What we want paint to do indoors is to flow from the brush in a coating that is more like an enamel. After the brush has passed by and left its deposit, that coating must of its own accord continue its flow to a perfectly smooth, hard surface that may be either glasslike in its polish or ground-glasslike in its texture.

OIL PAINTS

In general we have, for inside work, a choice between water paints and oil paints. To consider

the second first, oil paints are mixed with a basic pigment of lithopone in oils that flow freely and dry hard and smooth. They must be fast in color. They must give a surface that can be washed with a neutral soap and water. Of the oil paints, there are the so-called " flat oils " and the enamels.

In recent years, the " flat oils " (or oil paints that give a hard, smooth surface without gloss) have gained a tremendous vogue. They offer a pleasing texture that is free of the glaring high lights of reflection; a hard, washable surface; and stock colors that are well suited to our modern ideas of restraint in interior decoration. These colors are not all so dependable as regards fastness as we could wish, but this defect is one that the paint manufacturers are constantly striving to overcome. Curiously enough, the properties of the white lithopone base make pure white one of the chief offenders along this line. Strong sunlight, especially in conjunction with dampness, has a tendency to turn it a dirty gray.

New Plaster Walls. On plaster walls that have never been painted or papered, the best priming coat is a lead-base paint, such as is best for outdoor work. This gives a better grip on the plaster, and a good surface to take the flat oil paint. It should have a week, or even two, to harden in a warm, dry atmosphere — longer, if the drying conditions are not so favorable. For

the second coat, mix up one part of normal exterior paint to two parts of flat-oil paint. The third and last coat should be of the flat-oil paint, as it comes from the can; and particular care is needed to see that the mixture is thoroughly and frequently stirred from the very bottom.

In applying these flat-oil paints, it is easier and productive of better results if a fairly large flat brush is used; a six-inch width will do, but with practice a still wider one can be used to good effect. Do not try to brush these flat-oil paints out with the force used in exterior painting. Apply a rather heavier coat and distribute it evenly, without working over it as one does with lead and oil. The indoor work requires quicker action in moving methodically over the surface to be covered, without returning afterwards over any part of the work.

If the time element is of greater importance than the certainty of a good job, the priming coat as suggested above may give place to a coat of varnish size mixed with a little flat-oil paint — say, in the proportion of three parts to one. Varnish size is made by diluting good varnish with enough turpentine to prevent a gloss finish. The proportions vary with the character of the plaster surface, so that it is necessary to try out the size on a small space before fixing the final proportions. A glossy-varnished wall will not hold the later coats. This priming coat will ordinarily dry in two or three days, after which the second coat may be put on. This consists of the normal flat-oil paint into which has been stirred a pint of boiled linseed oil to the gallon. The final coat should be of the normal paint.

Still another method may be mentioned, as being the cheapest and quickest of all. It might serve for painting some unimportant room, or as a practice effort of which the best results are not expected. In brief, it calls for but two coats of paint with a glue-size coat between. The priming coat consists of flat-oil paint diluted with boiled linseed oil in the proportions of one quart of oil to the gallon; and this will require at least two days to dry. Apply over it a very thin coat of the glue size. This is made as follows: Put a half-pound of ground dry glue in an ordinary galvanized-iron bucket with a quart of cold water. When the glue has become soft, pour boiling water into the bucket until it is three quarters full, and stir the contents thoroughly with a stick. When the liquid has cooled, brush it over the priming coat, being careful to keep the coating thin enough to lie flat and not run. It may seem that you are merely putting on a thin wash of water, but the effect is none the less certain and useful. When the size has dried hard, put on the second and final coat of paint, using it as it comes.

Old Plaster Walls. The job of painting a wall that has been papered is one of the sort that tries

men's souls. That paper must be taken off, to the last reluctant shred; and before that task is completed, the amateur decorator will have convinced himself, if not the rest of the household, that the demolition of the entire wall and its replacement with new work would have required less time and less effort. Nevertheless, the satisfaction of playing a golf course in par is hardly comparable to the feeling of triumph that follows the sweeping out of the last batch of soggy pulp, the putting away of drop cloths, and the victorious survey of that mottled brownish wall that has been utterly subdued.

As a first step, brush over the wall paper all the warm water it will absorb. Wet one whole side of the room thoroughly before attempting to use the scraper. Then start at the beginning again and wet a single width of the paper from ceiling to baseboard. There are those who advise working the scraper from the bottom up; others who claim that downward action is better. Take your choice — either is hard enough. After the whole wall is apparently cleared, sweep it with a broom, to remove all the particles, and allow it to dry. The drying, I am sorry to say, will reveal small particles still in place. Wet these with a small brush and scrape them off. Sandpapering will remove the smaller ones more easily — as well as any tiny lumps of paste. If cracks are uncovered, or pieces of plaster broken off, patching may be

done with plaster of paris and a small plastering trowel. While the plaster is being troweled to a hard and smooth surface, keep it wet with a brush. Before painting, a thin coat of white shellac must be given to all such patches of new plaster, else they will later proclaim themselves.

When a flat-oil-painted wall needs repainting, sponge the surface down with water that contains a liberal addition of household ammonia. A pint of strong household ammonia to half a bucket of water, is usually strong enough.

Stenciling and Stippling. The amateur painter, when he has mastered the technique of applying flat-oil paint evenly and with due regard to the surrounding woodwork, may aspire to some of the more difficult modifications in the use of this material. Stenciling needs no word here beyond the respectful suggestion that the craftsman undertake no more than he feels reasonably sure he can finish. The work presents no great difficulty, but it does require painstaking, precise attention to detail, and it is not to be undertaken as a rush job.

Another variation of interior wall painting is the stippling of one color upon another. A flat base color is applied in the regular way; and after this has dried, a small section of the wall is covered with the secondary color. Before this has started to harden, it is partly removed by tapping it with a handful of cotton waste, a crumpled cloth, or a

sponge. It is essential that the effect of this stippling action be kept uniform over the whole surface. Allow the stippling material to absorb neither too much nor too little from any one part of the surface. The work is made much easier by following the directions of the paint manufacturer supplying the secondary color, which is one ground in oils especially adapted for the treatment.

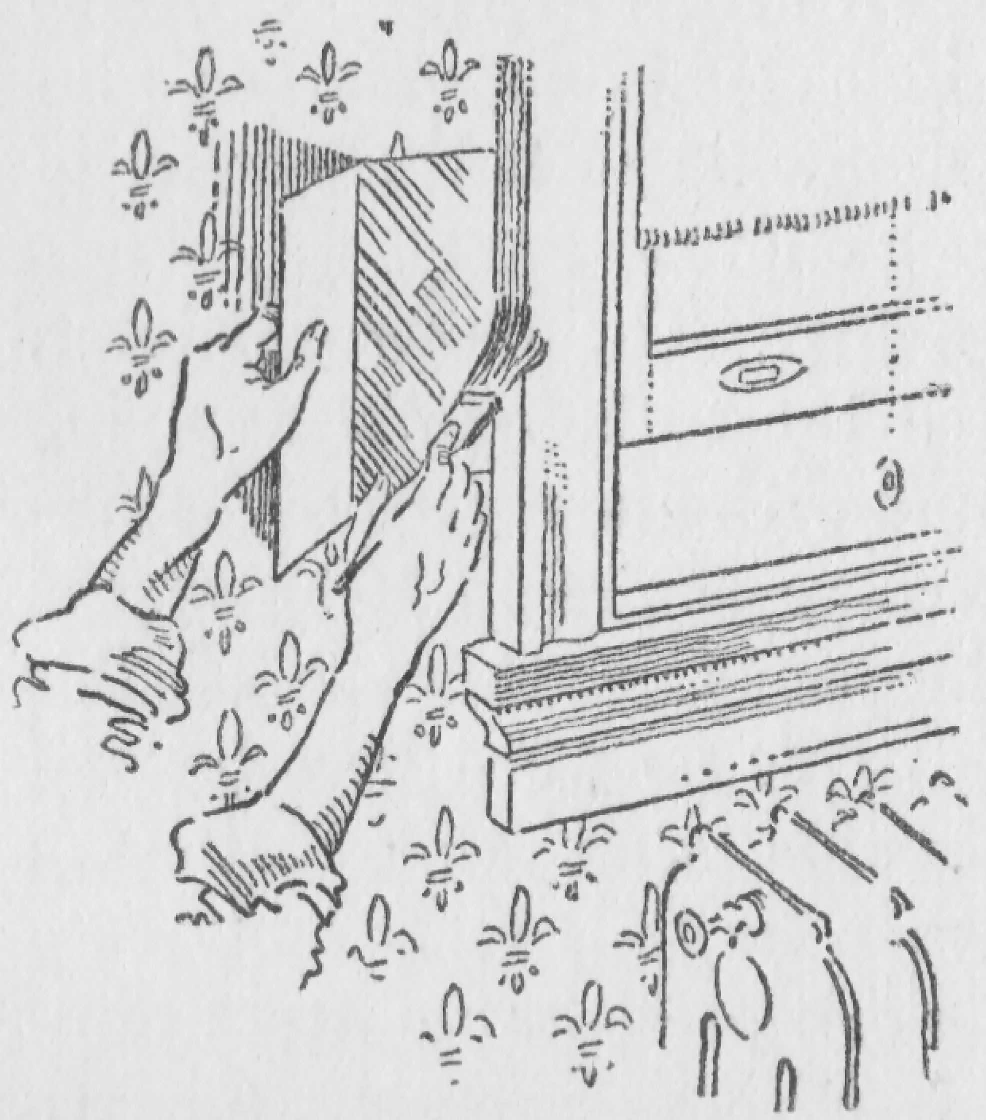

FIG. 19: A piece of tin, bent (as shown) for convenience in handling, safeguards the wall paper or adjoining woodwork in painting trim.

Interior Woodwork. The use of flat-oil paints upon interior woodwork brings up no new problems. A smaller brush will, of course, be found more convenient than the wide ones used on plaster wall surfaces. The priming coat of lead and oil paint is advisable, followed by two coats of flat oil as described for the first and best method of wall painting. A shield consisting of a strip of tin about six by eight inches and bent along its longer dimension at the middle through, say, 30 degrees, forms a convenient protection for adjacent wall paper or

glass. The shield is held in the left hand while the right does the painting, as shown in Figure 19.

WATER PAINTS

Our modern water paints have largely displaced the old-time calcimines, for they may be washed by light sponging with water and a mild soap. Sold in powder or paste form, these paints utilize casein, soybeans and alkyd resins in the pigments and are identified by these materials as type names. They are made ready for use by the addition of water, are easily applied, dry without gloss in an hour or so, and come in white and many pastel colors. For use on plaster, wall board, wood, metal, oil-painted surfaces, and even over old wall paper, these paints can be made to solve most interior decorating problems. One place where they should not be used is where steam is prevalent — kitchens, bathrooms and laundries.

Sizing or other priming coats are rarely needed under these paints; in fact all three types are satisfactorily applied over surfaces that are damp and even strongly alkaline, such as green concrete or fresh plaster. On the other hand, they should not be used over an acid surface, such as concrete that has been washed down with muriatic acid. Of the three types, the alkyd resin paints are the most highly resistant to water, and will stand scrubbing very much like the flat oil paints.

Manufacturers' directions will govern the mixing and the containers to be used. Application is made with a flat brush, as large as can be handled conveniently. No effort should be made to brush *into* the wall, as with oil paints. Flow it on rather freely and evenly, without brushing back over the surface covered.

A wall that has previously been covered with calcimine or one of the non-waterproof paints must be washed down thoroughly, every trace of the calcimine being removed, before it can be redecorated. Surfaces that are greasy or those that have a gloss should be washed with trisodium phosphate solution (follow directions on package, as it is easily made too strong), followed by sponging with clean water.

After painting walls with these water paints do not attempt washing within the first thirty days. Even after this period of hardening, vigorous scrubbing of the casein or soybean types is to be avoided.

Brushes may be cleaned of these paints in soapy water, immediately after use; if they have hardened, benzine will probably soften them.

CHAPTER X

Varnishing and Enameling

If there is a fairly common lack of knowledge regarding paints, there is a vastly greater ignorance of varnishes. And this is not surprising, for varnishes present a most complex and extensive group of protective coverings. Although there are undoubtedly many men who understand the nature, composition, and handling of the particular class of varnishes in which they work, there are probably few men indeed who have a similar knowledge of the whole range of over two hundred distinct commercial varieties. So it is fortunate that we who wish to know something of varnishes from the standpoint of home craftsmanship may narrow down our investigation to a few members of the vast and intricate group.

Perhaps the most fundamental point to be learned and firmly borne in mind is this: a paint is sold by its maker with the knowledge that it may and should be altered by the user in various ways for various purposes; a varnish is practically a chemical compound rather than a mere mixture

of certain ingredients, should not be altered by the user, and should never, except by the maker's explicit instructions, be mixed with any other varnish, even of its own class. For the same reason, the varnish brush must be kept inviolate. All sorts of mysterious failures follow the use for varnishing of a brush that has been employed for any other purpose.

Brushes used for shellac and those used for varnish must not be interchanged. Clean shellac brushes in denatured alcohol only, and varnish brushes in turpentine only. A really expert varnisher never cleans his brushes at all, but keeps them suspended, when not in use, in a varnish similar to that which he uses but made up without driers. It is a good plan to mark varnish and shellac brushes, so that they will not be inadvertently used for other purposes.

Before starting to use a new varnish brush or one that has been cleaned and dried, pour out half a cupful of the varnish to be used, dip the brush in it, and scrape out the varnish on the edge of another cup. Continue this operation until the original half-cupful has been through the brush. Throw away this varnish, or use it, strained through a cloth, for less important work.

When, after a varnishing job, a depleted can of the material remains, pour the contents into a smaller can that may be filled full and tightly covered. Otherwise, oxidation will occur, to

the deterioration of the varnish if not rendering it wholly useless.

Without attempting to probe too deeply into the manufacture of varnishes, it may be interesting to know that these useful protective coverings are made of gum resins, certain hydrocarbon compounds, metallic salts, waxes and fixed vegetable oils, volatile oils, and animal oils. A varnish is not merely a solution of a gum resin in oils; through scientific selection and grading of the ingredients, and a close combination of these under treatment by heat, it approaches the quality of a stable chemical compound.

Although there are various tests for the desired qualities in a given varnish, some simple, others possible only in a laboratory, the amateur craftsman has, practically speaking, but one guide, and that is the manufacturer's reputation. Needing a varnish for a particular purpose, the wise buyer will go to a reputable house and buy the best product that is offered in that particular class. "Cheap" varnishes will continue to be made and sold, for the manufacturer must supply his market; but the amateur who would take some pride in the work of his hands will not risk failure by accepting the handicap such materials entail.

Classifications. Broadly speaking, varnishes may be classified as "Oil" varnishes, "Spirit" varnishes, "Japans", and "Enamels."

Oil varnishes are combinations chiefly of a gum

resin and linseed oil, with enough metallic salts to assist drying and enough turpentine to make the varnish flow readily.

Spirit varnishes consist chiefly of gum resins in volatile liquids. Shellac and dammar varnish are examples.

Japan varnishes are again subdivided into painters' japan and decorative japans. The first contains metallic salts and gum resins in a drying oil, thinned with a volatile liquid. The decorative japans contain asphaltum, etc., and are dark varnishes.

Enamels are, for our purposes, varnish paints, or varnishes to which color and opacity have been given by the addition of pigments.

Unfortunately, the above classification, basic though it is, is not going to serve all our needs. We shall wish to choose a varnish for a certain purpose or location, so we shall want a group classification that tells what varnishes do rather than what they are.

For use indoors, there is a large group of interior varnishes, designed to give various surfaces, from highly lustrous through gradations to a flat, lusterless coating. These varnishes are developed for the qualities of light color, fairly rapid drying, permanence of luster, ability to withstand cleaning.

In this indoor group will be found a corresponding variety of interior enamels.

A second class contains the rubbing varnishes, used for fine woodwork and furniture. In these the main desideratum is hardness, to withstand the abrasive action of pumice stone and friction. They must be unaffected by the oil and water used in this process, and must be capable of developing a very high polish. Closely associated with these are flowing varnish, designed to give a smooth surface of high luster without rubbing, and chair varnish, designed particularly to retain its hardness at higher temperatures.

The floor varnishes form another distinct group, marked by high elasticity, quick drying, and resistance to moisture. With this group are the varnishes containing more or less transparent coloring matter.

Coming to outdoor use, we have the coach varnishes and exterior architectural varnishes, which, above all other considerations, must be durable against changes in weather and temperature.

Spar varnish, originally designed to resist the attacks of water and salt air on ship spars, now comprises a large and exceedingly useful group of tough, highly elastic varnishes. These are used not only for exterior work but for floors and dining-table tops, and in many other places where elasticity and resistance to heat and moisture are essential.

Then there are the shellacs — simple solutions of shellac in alcohol. Grain-alcohol shellac and

wood-alcohol shellac were formerly thus differentiated, but to-day denatured grain alcohol is the common solvent. There are " white " or light-colored shellacs, and orange shellacs, the first being chosen when a finish requires an approximately colorless and clear covering. Shellacs are very quick-drying but are not durable, and they turn white from contact with water. Hence they are almost always used as an undercoating for some more lasting finish, such as wax or a durable varnish.

New Woodwork. With this very superficial knowledge of varnishes, let us assume that we wish to give a varnish finish to new woodwork. In the first place, it is likely that we shall wish to have our finished job show the wood in its traditional color. That means staining before the varnish coating is applied.

First of all, however, the wood should be sandpapered to a smooth surface. Some of the paint-supply houses now sell packages of sandpaper in assorted degrees of fineness. Garnet paper is a superior grade, sharper and more lasting. Number $1\frac{1}{2}$ is quite coarse, suitable for smoothing the edges of tool marks. Numbers 1, $\frac{1}{2}$, 0, and 00 are the other common degrees, becoming finer in the order given. Number 00 is so fine that it would be useful for sanding the first or second coat of varnish in preparation for a following coat. Steel wool, which comes correspondingly graded,

is preferable, however, to sandpaper for varnishing and all other interior work. It cuts like a great bunch of tiny chisels, taking off a complete top surface without deep scratching. Sandpaper does better for exterior paint, where the purpose is to remove merely the rough excrescences.

In stains we are confronted with the necessity for choosing between wood dyes and the oil and pigment stains. The penetrating wood dyes are absolutely necessary in the case of wood that has already been stained and is to be refinished, but otherwise it will probably meet most requirements if, for a reason that will appear later, we confine ourselves to the oil stains for all work that is to be covered with varnish. Try the stain first on a small piece of waste wood of the kind to be finished; and thin it as directed on the can if a lighter tone is desired. Allow this to dry at least over night and then sandpaper it with Number 00, as the stain raises the ends of the grain fibers.

So much for the color. If the wood is a close-grained sort, we are ready for varnishing. If it is open-grained, it will first have to be filled. Close-grained woods are: birch, cypress, gum, maple, poplar (whitewood), spruce, white pine, yellow pine, and redwood. Open-grained woods are: ash, rosewood, butternut, chestnut, oak, elm, mahogany, pitch pine, and walnut.

Fillers for the open-grained woods are made in two types — liquid and paste — of which the

paste alone is worth using. They are supplied in the various wood colors and also in a transparent variety that fills the wood without changing its color. Thin with benzine the paste filler selected, working it to a fairly thick cream. Apply it with a brush, and, when it has started to set (which will be indicated by partial flatting), wipe off the surface *across* the grain with a piece of soft cloth. The purpose of the filler is to level up all the tiny interstices in the grain, so as to form a perfectly smooth surface for the varnish. Allow the filler at least forty-eight hours to dry hard.

Now that we have our wood properly colored and brought to a smooth surface, it is necessary, if a wood dye or acid stain has been used, to seal the color in the wood with a coat of white shellac. Without this seal, varnish, if applied over surfaces stained with spirit or acid, will take up some of the stain, thus producing spottiness or sometimes preventing proper drying. The coat of shellac should be thin and smooth; an addition of denatured alcohol to the shellac as bought is usually necessary. It may be repeated here that this step is not necessary if an oil stain has been used.

After this, the varnish itself may be put on. A warm, dry atmosphere is essential for successful varnishing. Brush on the varnish freely and quickly *with* the grain of the wood. Without again dipping the brush, work the varnish *across* the grain; this will cover any small spots missed

in the first flowing. Scrape back on the edge of the cup the excess of varnish that is in the brush and once again go over the work *with* the grain, making each stroke run the full length of the portion worked. Keep scraping the brush over the cup's edge to remove the excess. The idea is to flow a generous quantity of varnish on the surface and then, without adding more, work it to an evenly distributed coating with the cross-brushing and final stroking. A small amount of practice will show you just how much of an area can be flowed on and brushed out without having it get too tacky.

After the first coat has dried hard, rub the surface dull and smooth with Number 00 steel wool. Do not rub through the coat; merely take off the top gloss and the tiny specks that break the surface. Rub with the grain, not across it. Apply at least two coats, and preferably three, rubbing after each coat except the last.

For a really fine job, such as a table top, use powdered pumice stone and water, instead of the steel wool. You will need a thick piece of rubbing felt, such as your paint-supply house carries for the purpose. A piece about three by six inches is sufficient. Put the powdered pumice in a saucer and, after moistening the felt, dip its bottom surface into the pumice and rub with the grain. Do not overdo the rubbing; six or eight strokes over each portion is usually sufficient. For moldings

or uneven surfaces where the felt pad will not serve, use a small hand scrubbing brush in the same way.

If a dull finish is wanted, the final coat may be rubbed lightly with powdered rotten stone and water in the same manner, and finally cleaned off with furniture polish. Or, use a flat finishing varnish for the last coat.

A rubbed table top that is used to any extent will soon take on again the gloss that has been cut off.

Some finishers prefer to use oil with the pumice for rubbing, but the method is otherwise the same.

Old Work. For revarnishing old work, if the surface is unbroken and without cracks or checking, wash it with linseed-oil soap and rinse it with clear water. Then rub it with Number 00 steel wool and clean it down with benzine. When the surface is dry and perfectly clean, apply the varnish as with new work. If the old varnished surface is bad, remove it entirely with a prepared varnish remover. It is an unpleasant job at best, for the remover, when spread freely over the surface with a brush, softens the varnish into a jelly-like mass. This, if thin, can be wiped off with cloths moistened in the remover. If it is thick, the bulk of it can be taken off with a scraper; after this, scrubbing brushes and old cloths, well moistened with the remover, will finish the cleaning. After the surface is as clean as it can be made, scrub it well with benzine to remove the

remover and rub it down with Number 0 sandpaper.

The powerful solvent used to soften the varnish usually takes part of the filler as well; if any filler has been used, the wood will have to be refilled as described above, before the new varnish is put on.

CHAPTER XI

Floor Finishing

Of all the inside of the house, the floors receive the hardest usage. With this problem constantly before us, it would be logical to expect that most people would know how to solve it; yet there seems to be a greater lack of knowledge on floor finishing than on any other phase of painting or varnishing.

Smoothness of surface is the first consideration, for any unevenness or irregularity in the surface invites wear and rapid deterioration.

New Floors. A new floor will be the better for seasoning in place for at least a month, after which it is thoroughly scraped and sandpapered. Floor finishers use an electrically driven scraper. Scraping by hand is a task to daunt even the most enthusiastic amateur craftsman.

A paste filler of the desired color will obviate the necessity for a separate stain if the wood be an open-grained sort. If close-grained, the wood will first be stained, unless the lightest possible natural finish is required. Three coats of a good

floor varnish, each coat except the last rubbed with Number 00 steel wool, will give a good wearing surface. If a dull finish is desired, the final coat may be rubbed with pumice stone and water.

Never put on a coat of varnish without wiping off the dust with a cloth moistened in benzine. Better still, use a cloth that has been dipped, the night before, in a mixture composed half of varnish, half of linseed oil, and then merely wrung dry. This will pick up all lint and dust. Dust is the great enemy of smooth varnishing, and there will be enough of it to cause regrets even with the greatest care. Never put on a following coat before the undercoat is thoroughly dry. This will require at least forty-eight hours. To prevent lapping marks, always varnish a strip of two or three boards their full length before starting others. For the first coat on a hardwood floor, it is advisable to add a cupful of turpentine to the gallon of varnish. This assists penetration and prevents "crawling."

Wax Finish. If a waxed finish is desired, put it on over the finished varnishing with a cloth pad and polish it with a weighted waxing brush. It was formerly considered good practice merely to shellac a floor two coats and then wax it. The trouble with this method is that the wax, unless daily renewed, is worn thin in spots, and the shellac is not strong enough of itself to prevent wear from reaching down to the wood fibers.

Soft Woods. For finishing cheaper woods, in which the grain is not particularly attractive, a floor varnish prepared with pigment coloring by the maker is used instead of the first two coats of varnish. Always finish with a final coat of clear varnish, to keep the wear off the color. It is well to try out these colored varnishes on a sample piece first, since each coat adds its portion of pigment and the final color may be darker than is desired.

In the case of old softwood floors, or where decorative reasons require it, painting may take the place of varnishing. The surface must be absolutely clean, and, in particular, free from grease and moisture. Fill any cracks and nail holes with a special filler, made and sold for this purpose, pressing it in fully and firmly with a putty knife. This operation should be deferred until after the first coat of paint or the filler will not grip the wood. The first coat will penetrate the wood better if it is thinned by the addition of a pint of raw linseed oil to the gallon. Three coats of inside floor paint should serve the purpose; and they should be fairly thin coats, so as to insure a good binding between them.

If a particularly good job is desired in a painted floor, sandpaper the surface smooth after the second coat of paint — provided that the two coats cover perfectly — and apply two or even three coats of floor varnish as directed above. These will give a transparent wearing surface over the paint, protecting it from abrasion.

Care of Finished Floors. Having obtained a suitable floor finish, see that it is never washed with ordinary cheap soaps, which contain free acids, alkali, or lye; nor with any washing powders; nor with hot water. Wiping it up daily with a cloth dampened with a prepared floor oil will keep the varnish in good condition. When washing is needed, linseed-oil soap is best, but the floor should not be flooded with water. Have a square yard or so washed, rinsed, and wiped up dry — then another portion. If the floor is wax-finished, polish it daily with a weighted waxing brush; and keep adding wax with a soft cloth, particularly on parts that are much used. When the wax becomes dirty, remove the whole coating with benzine or turpentine and apply fresh wax.

Incidentally, a linoleum floor covering will wear indefinitely if varnished with a good floor varnish. It should be thoroughly cleaned first with linseed-oil soap and, when dry, wiped with benzine. Give it two or three coats of the varnish. Each coat should have not less than forty-eight hours for drying. Rubbing between coats will probably not be necessary.

CHAPTER XII

Plumbing

It is unlikely that the amateur craftsman will aspire to the construction of new plumbing. If he should, he will do well to seek assistance in books devoted to that subject, several of which are readily available to everyone. There are no insuperable difficulties in the way of his so doing, for, with some knowledge of the principles involved, the mechanical work does not demand either great skill or special dexterity. He would undoubtedly have considerable difficulty in making a "wiped joint" of lead pipe, but modern plumbing practice seems to have abandoned this one difficult operation with no loss of efficiency.

In these pages, however, we shall confine our plumbing activities to the few simple problems that are likely to arise through clogged pipes, leaky faucets, temperamental flush tanks, and such minor annoyances. These difficulties, although they may easily disrupt domestic tranquility, may almost always be remedied with the

aid of a very little knowledge and still less actual work.

Faucets. Probably the most common trouble with household plumbing has to do with the faucets, or in plumbing parlance, the "bibbs." You may encounter one or all of three types: compression, ground-key, and Fuller. The first of these three has so many advantages that it has already displaced the ground-key type to a large extent and is gaining an ascendancy over the Fuller bibbs, formerly a standard for kitchen sink.

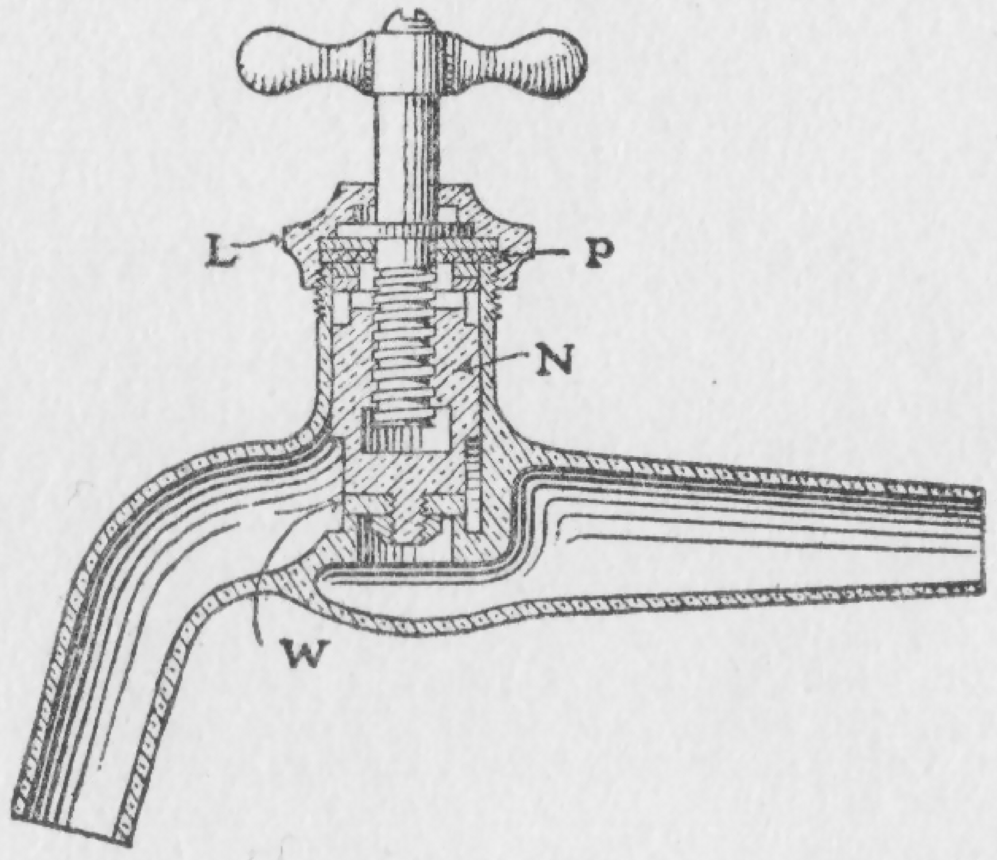

Fig. 20: Section through a compression faucet. *N* is the plunger nut, lowered or lifted by turning the handle shaft. *W* is a composition washer, giving a tight joint when compressed on its seat. *L* is the lock nut that permits handle and plunger nut to be withdrawn. *P* is packing to prevent leakage about the stem.

The compression bibb received its name from its method of closing the valve. Figure 20 shows a cross section, from which the action is clear. The handle shaft is coarsely threaded, lifting or lowering the nut *N*. This nut is fitted on the bottom with a washer *W*, held in place by a screw. The compression of this nut and its washer upon the seat of the cock closes the port against the water. When the faucet leaks at its outlet, the

washer has become worn and needs replacing. This is easily done with a wrench and a screw-driver. Turn the water off at the valve below the fixture, if there is such a valve; if not, at the main supply or branch. Loosen the lock nut *L*, and the handle and plunger nut may be withdrawn, permitting a new washer to be put in place of the old one. A leak at the top, about the handle shaft, indicates the need for new packing at *P*.

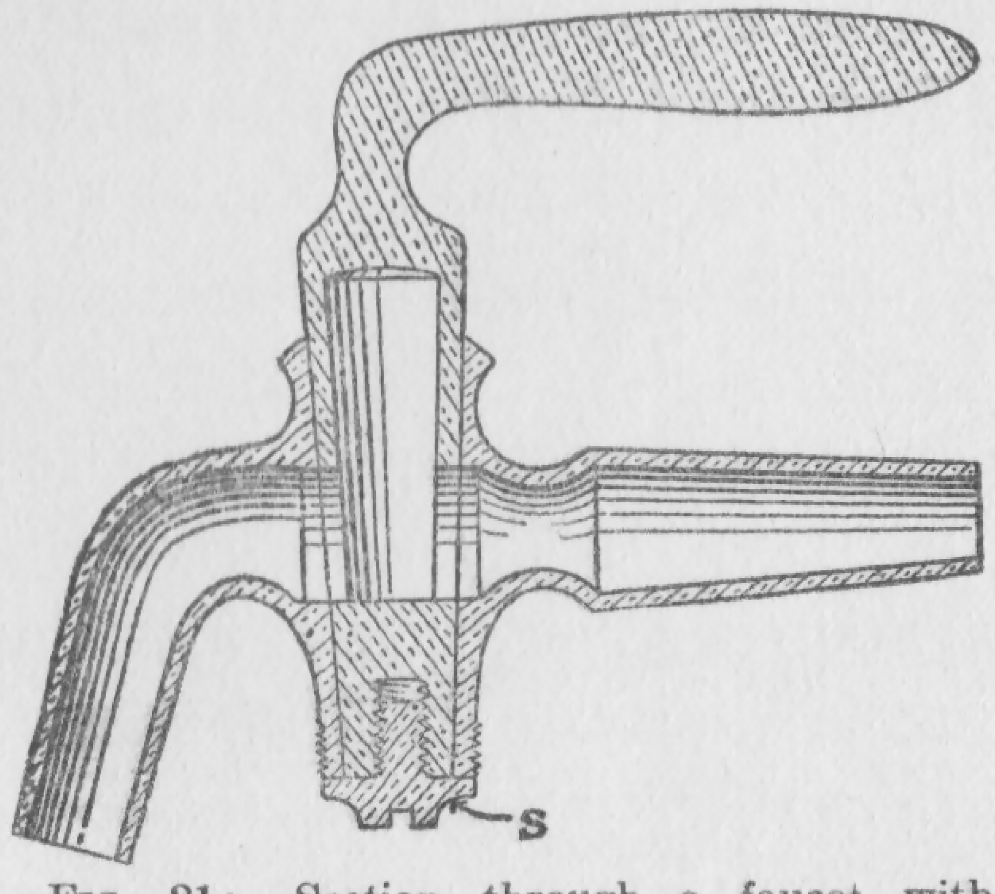

FIG. 21: Section through a faucet with ground-key joint. The screw *S* holds the key just tight enough to prevent leakage while permitting it to turn.

Self-closing compression cocks, found chiefly in public fixtures, are quite similar in construction, with the addition of a spring that rotates the plunger down upon the seat when the handle is released.

The ground-key bibb (Figure 21) has a tapered brass plunger through which runs a channel. This plunger forms a ground joint with its seat and, when turned forty-five degrees from the closed position, allows the water to pass freely through. The plunger is kept tight enough to prevent leakage, but loose enough to permit turning, by the screw *S*. A leaky bibb of this type

probably needs the regrinding of the joint. After the supply has been turned off back of the cock, the joint is ground by putting a little valve-grinding compound (emery dust and grease) on the plunger and rotating the plunger back and forth, to polish the two surfaces to a perfect joint.

The Fuller bibb works upon a different principle (Figure 22). The shaft leading down from the handle — usually a lever — has an eccentric end that draws the rubber plug *P* against the port, to close it. It will readily be seen that a worn plug is easily replaced by unscrewing the whole bibb at the joint nearest the plug. A leak in the top packing can be repaired by taking off the lever and top lock nut. It is well to keep on hand a small stock of the rubber plugs and composition washers in the proper sizes for the cocks throughout the system.

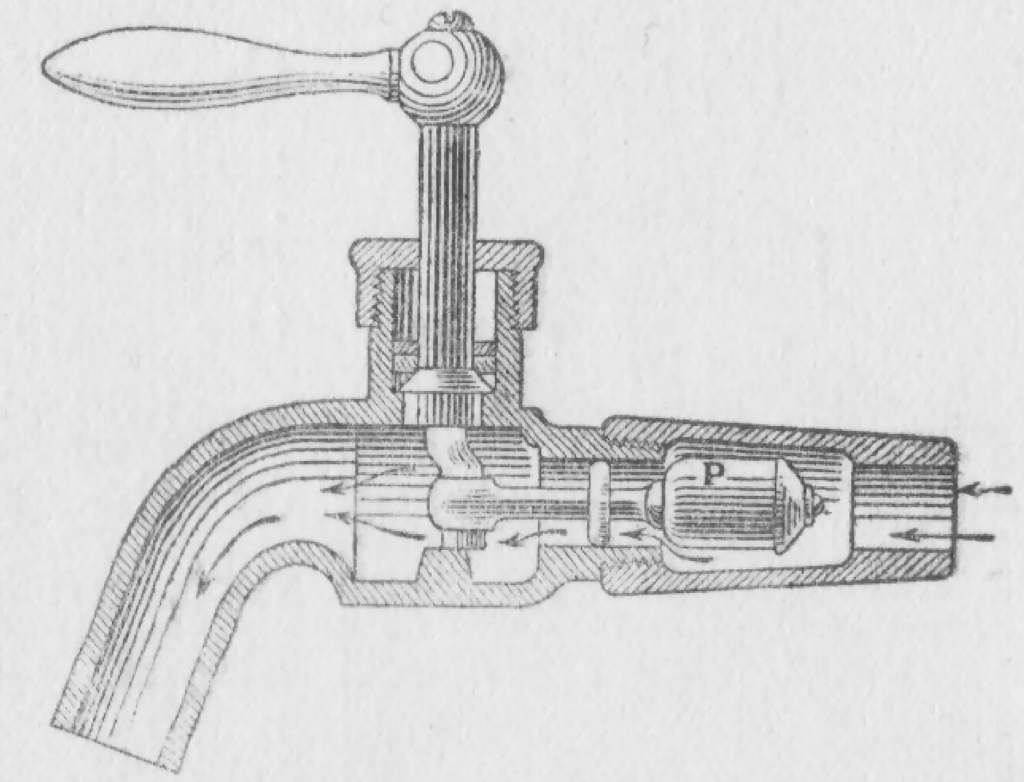

FIG. 22: Section through a Fuller type of faucet, in which the eccentric on the stem draws the rubber plunger *P* against its seat, to cut off the flow.

Hand Valves. Valves differ from cocks chiefly in their external appearances. The wheel handle of an ordinary globe valve (Figure 23) seats a plunger fitted with a composition washer, just as

does the compression bibb. This washer is replaced by unscrewing the top of the valve at *A*, rather than merely the top nut *N*. The top nut controls the friction of the plunger shaft in its thread and is removed for repacking.

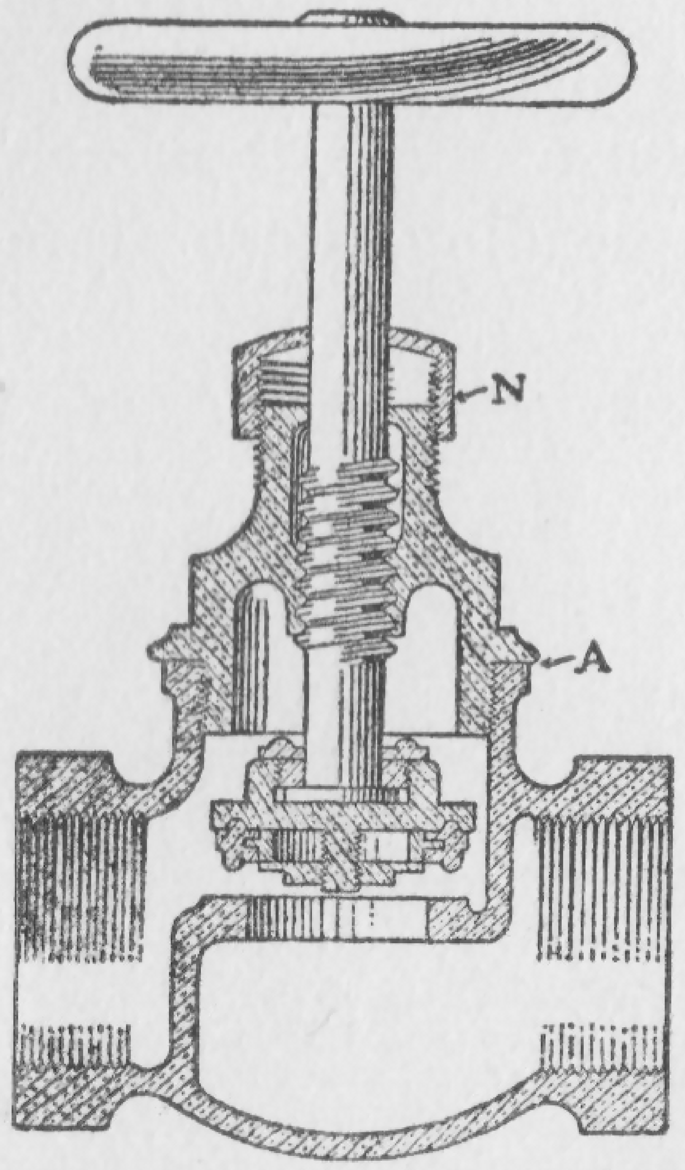

FIG. 23: Section through a globe valve. On the lower end of the stem, a composition washer seats upon a horizontal opening. For renewal of the washer, the top is unscrewed at *A*. The nut *N* secures packing about the stem.

A gate valve (Figure 24) has a pair of brass gates *GG* sliding up and down under the control of the handle and stem. When the valve is closed, the wedge *W* forces the pair of gates tightly against their respective sides of the opening. The top nut, under the handle and about the stem, controls the friction of the stem and holds the packing in place.

There is one other type of valve with which it is well to be familiar, the stop-and-drain, which is usually to be found controlling branches or supply mains in the cellar. This valve, when turned, shuts off the flow of water and at the same time opens in the side of the valve a port that drains off the water that has passed beyond the valve itself. A branch leading to an outside hose connection called a " sill cock", will have

such a valve if the piping has been run *up* to the sill cock instead of *down*. In the latter case, the sill cock itself will drain the branch when the water is shut off the branch. If the branch leads down from the sill cock, a stop-and-drain valve, placed at the low point, will furnish the only convenient means of drawing the water out of the pipe when there is danger from freezing.

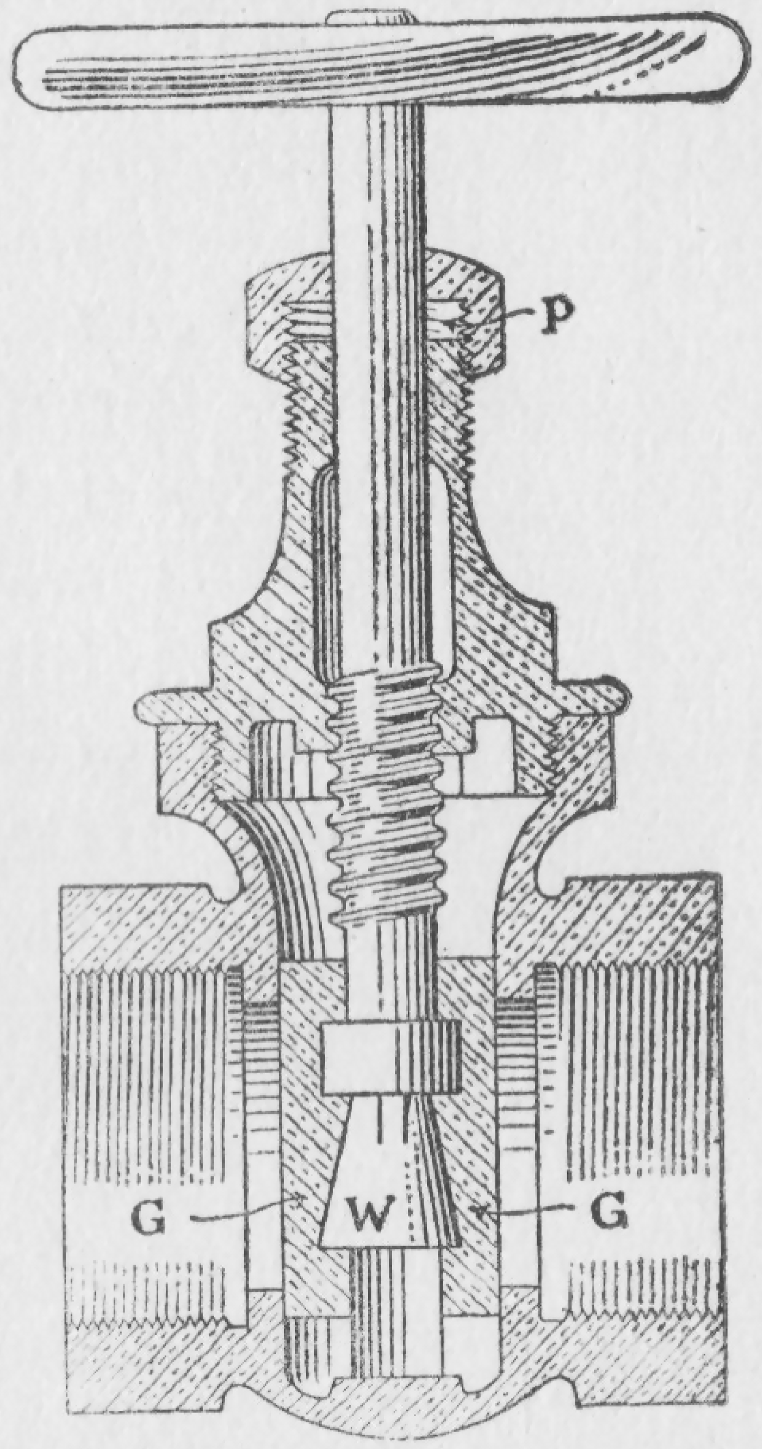

FIG. 24: Section through a gate valve. The gates *GG* are held against both openings by the wedge *W* on the end of the stem, and slide up to open the valve when the handle is turned. The stem is packed against leakage at *P*.

When, therefore, a valve shows this extra outlet, either as a small hole or a projecting tube, be prepared with a bucket to catch the drip when the valve is closed.

Traps. All modern plumbing fixtures are supplied with traps in the waste line, for the purpose of securing a water seal between the unpleasant sewer gases and the room in which the fixture stands. They are uniformly well-behaved in their automatic service, and it is only when one becomes clogged that it brings to us the realization of its importance.

In its simplest form, the trap is a piece of pipe shaped like the letter S laid on its side (Figure 25). Water flowing through the trap in the direction of the arrows leaves a water seal when the flow stops. A plug, usually located on the bottom, as shown at *P* in Figure 25, permits the removal of material that may have caused a stoppage.

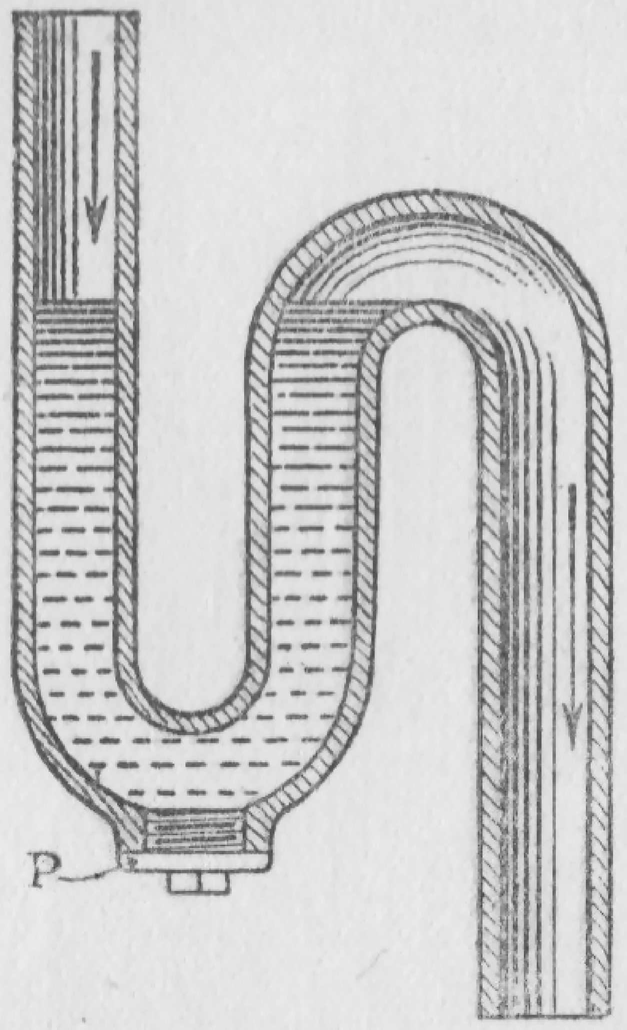

FIG. 25: Cross section of the simplest form of trap, the S-trap. Most modifications of the trap enlarge the middle leg, sometimes including a floating ball, in the effort to prevent siphonage. The screw plug *P* is removed to clean the trap.

One of the faults of the S-trap lies in the fact that its water seal may be broken. Siphonage, evaporation, capillary action in a piece of string hanging over the dam, back pressure, momentum — any one of these things may break the seal. As a result, there are a great many types of trap designed to forestall these actions. One common type has its middle section formed into a cylinder larger than the pipe itself. Another type depends upon a floating rubber ball to close the inlet after the water ceases to enter. However, it is unnecessary to dwell upon these modifications. Each one has its clean-out plug or opening, and this is the first place in which to look for trouble when a stoppage occurs. It is not a pleasant job at best, but with a pail to catch the

dammed-up water, a wrench to remove the plug, and a piece of stiff wire, the trouble is usually remedied very quickly.

If the stoppage is not complete, a kettle full of boiling water containing potash or caustic soda will often cut away an accumulation of grease such as periodically forms in the waste pipe of the kitchen sink, and save opening the trap itself.

Another weapon that is often effective in cases of stoppage is the tool known as a "plumber's friend." The name is not particularly apt, for more often the tool turns out to be a "plumber's enemy" in that it cuts him out of a repair job. It consists of a stiff rubber cup, on the closed end of which is fastened a heavy stick. When the cup is placed over a waste pipe opening in the fixture, considerable pressure can be exerted in the pipe by depressing the cup sharply, forcing the air that it contained down the pipe against the obstruction. Released, the cup assumes its former shape, sucking the air back again. Several agitations of the tool in quick succession give a strong push and pull on the stoppage, particularly if the pipe is practically full of water above this point. The tool is so powerful in its action that it occasionally will force a leak in a screw joint or about the trap's clean-out plug, especially when the gasket of the latter is badly worn.

Flush Tanks. One other feature of modern plumbing will occasionally give trouble, and that

is the flush tank. Of all the plumbing apparatus, it is perhaps the most delicately adjusted and the one most dependent upon mechanical aids for its action. Figure 26 shows a cross section of a tank filled and ready for discharge. A button or handle on the outside of the tank raises the

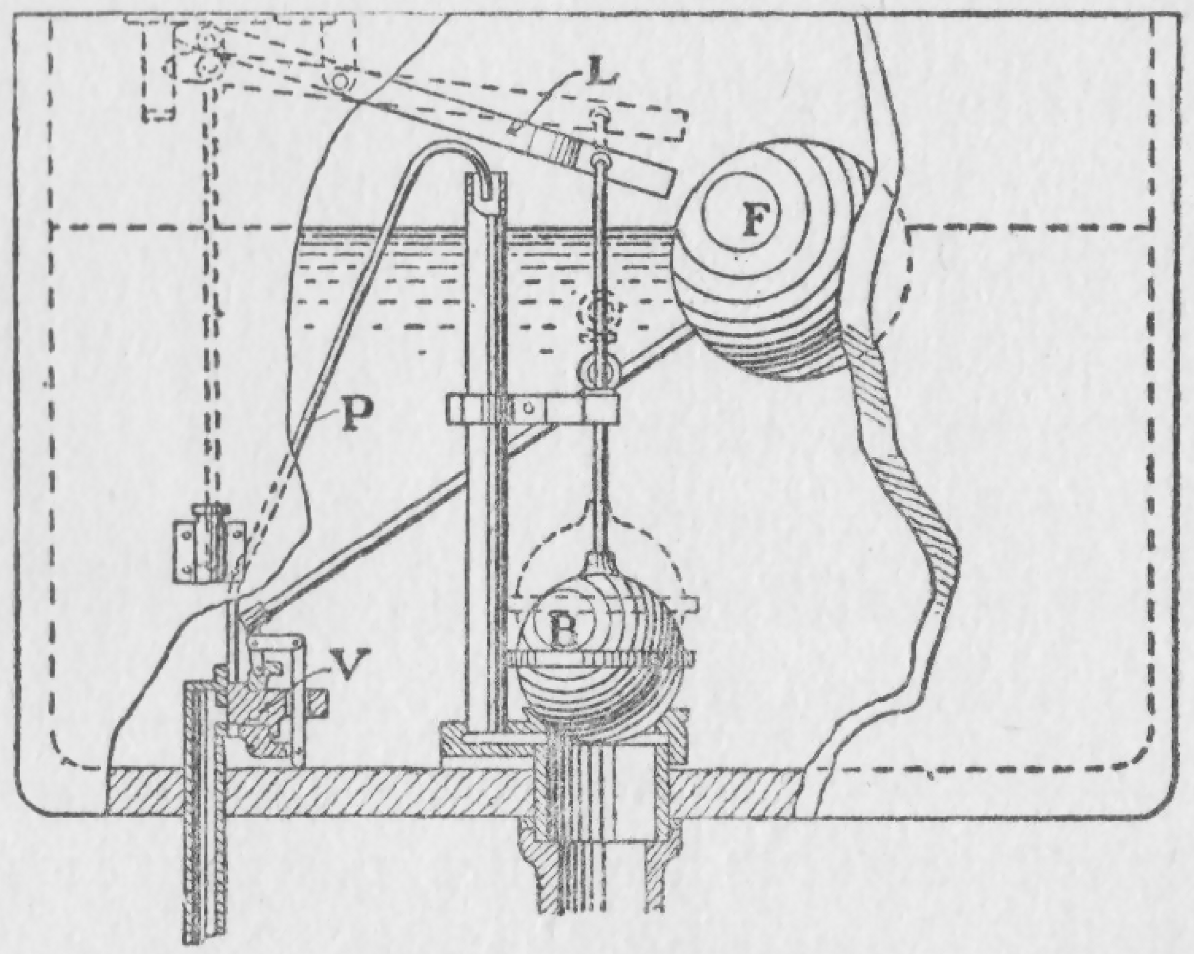

FIG. 26: The flush tank in one of its several closely similar forms. The lever *L* is raised by an outside button or knob, lifting the rubber ball *B* from its seat. Once the water starts flowing under the ball, the latter floats until the tank is emptied and the ball is deposited once more on its seat. Meanwhile, the copper ball *F* descends as the level lowers, opening the intake water valve *V*. As the tank fills, this valve is slowly closed by the raising of float *F*. *P* is a small copper pipe carrying enough water through the standing waste to restore the water in the toilet bowl.

lever *L*, and with it the rubber ball *B* by means of the stem. Once raised from its seat upon the outlet pipe, the ball floats on top of the water, whose descending surface again deposits it on top of the outlet. Ring guides assure its descent on the proper spot. Meanwhile, the float *F*, a closed hollow copper ball on a lever, descends with the surface of the water, thus opening the

supply valve *V*. This supply valve is small, so that the water enters slowly and more or less quietly. With the tank empty and the ball *B* once more closing the outlet, the tank fills, slowly raising the float-valve ball and lever and finally closing the supply valve.

Another modification of the flush tank employs a tubular stem and plug for the outlet control. When raised by the button or handle, the plug is held up by means of a trap that is finally pulled out by the float ball as it reaches its low point.

In either of these forms of tank, a small brass pipe (*P* in Figure 26) leads from the supply pipe into the outlet pipe, replacing in the bowl the water carried off by siphonage. The flow in this small pipe is controlled by the same valve that controls the tank supply.

The chief cause of trouble is the failure of the outlet ball (or plug) to seat properly. The hollow rubber ball used in one type becomes cut by the edges of the opening and fills with water. Or its surface becomes so roughened that it no longer makes a tight closing. Fortunately, it is an easy matter to replace the ball by unscrewing its stem — the tank having been emptied and its supply pipe having been closed, back of the inlet valve. In the tube-and-stopper type of tank outlet, the composition washer on the plug may be replaced. These supplies are kept in stock by the plumber

supplying the fixture; but, as in the case of bibb washers, much time and inconvenience will be saved by having several of the needed parts in the home workshop.

Occasionally, too, the copper ball controlling the inlet valve becomes punctured and, filling with water, fails to close the supply. Usually no great damage results beyond the waste of water; for when filled, the tank overflows through a standing waste pipe. This copper ball usually bears a tapped socket into which the lever arm is screwed; so that the ball may easily be replaced.

These flush tanks are so designed and so fitted, when they leave the factory, that the ball float permits the tank to fill to the proper level before the supply valve closes. Sometimes, due to carelessness in installation, the valve closes when the tank is only partly filled. Bending the float-valve lever arm upwards will remedy this fault without the necessity for readjusting the valve itself. Bending it down, likewise, is an easy way to prevent the tank's overflowing through the standing waste pipe.

Draining. Draining the whole system of water when a house is to be closed during freezing weather is a task that sometimes proves troublesome, chiefly because the job is likely to be deferred until the last hurried moment before leaving. The water, it should be unnecessary to point out, will not drain unless air is permitted to take its

place. This is done by opening the faucets, beginning at the highest fixtures and working down to the cellar valves. And fortunate is the man who finds then that his plumber has located the lowermost drainage cock where the water will flow into a drain rather than necessitate the use of pails, washboilers, and such unwieldy containers to carry it upstairs and outdoors.

The hot-water boiler usually has a cock in the piping, at the top, that will allow air to enter the boiler as the water is drawn off below.

After the system has been drained, water still remains in all the traps. Force this out with a "plumber's friend" or withdraw it by suction, and replace with kerosene, a brine of half salt and half water, or one of the anti-freeze solutions sold for radiator use. The one exception is the main house trap, where the drain passes out of the cellar. The water seal should be left in this to keep out sewer gas. The trap is usually safe from freezing, but may be wrapped in burlap if exposed inside of the cellar.

An Ounce of Prevention. The really workmanlike plumber of to-day leaves all his branch-line valves marked with their respective outlets — preferably on brass tags wired to the valves. If he has not done so, it is a precaution well worth taking in a peaceful moment. Plumbing troubles have a characteristic habit of coming at the most inopportune moments, frequently when the only

one who knows the system is absent. By tagging the shut-off valves and by impressing upon all hands the location of strategic shut-offs, a lot of possible damage may be avoided. If there are shut-off valves for each fixture, this fact also should be made a matter of general household knowledge.

The freezing of pipes in an occupied house is one of those exigencies that should not occur in any well-designed plumbing system but that nevertheless occasionally do happen. Swathing the pipes with cloths that are kept hot with water; placing heated bricks against the seat of the trouble — such makeshifts will usually effect a cure; but the main thing is to make sure that the pipes are thereafter fully protected. Boxing in and filling about the pipe with sawdust or mineral wool will help on exposed situations; and this is sometimes easier to do than incasing the pipes completely in asbestos or air-cell covering. The fact should be borne in mind, however, that, according to tradition, frost, unlike lightning, does strike again in the same place.

CHAPTER XIII

Electric Wiring

The installation of an electric circuit for bell work or for lighting is, in a sense, less of a craft than is any of the other subjects discussed in these pages — plumbing possibly excepted. In electric installation practically everything depends upon the theory — the design and the execution of the work is relegated to a place of far less importance. This is not the case with most crafts. In woodworking, for example, the theory or design of a miter is of far less consequence than the manner in which the hands execute it — the nicety with which the edges are cut, matched, and fitted together. Given, however, a certain problem in wiring, with the layout of circuit and outlets designated, a trained electrician and a novice would probably produce equally satisfactory results, at least in so far as the ringing of the bells or lighting of the lights is concerned. The electrician's work will be neater, and he will do the job in less time, but in working results the novice's job will be as good. On the other hand, the fin-

ished work of a novice painter will be easily distinguishable from that of the expert.

It is not to be expected, therefore, that many will embrace electric wiring as a hobby. Radio wiring, of course, is upon a far higher plane, not only on the score of a more complex theoretical basis, but also because in this field the execution or craftsmanship of the work is a far more important factor in the final working results.

Nevertheless, electric wiring for lights and bells in the home is one of the things that the self-reliant man prefers to understand in all its practical details. Although he may not choose this wiring, as he certainly would not choose plumbing, as an indoor sport, he nevertheless prefers to make himself the master of its rather simple elements, both in design and in execution.

The Simplest Circuit. Every electric bulb depends for its light on three essentials: a source of power — either battery or public-service supply; a pair of insulated wires to bring this power to the lamp, through its high resistance filament, and back to the source; and a switch by which this circuit may be joined and broken at will, to light the bulb or put it out. The source, whether a battery or public-service current, may be considered as a "head" of electricity, corresponding to a head of water as maintained by the public-service water supply. In the case of the water, the flow through the pipes is released by faucets,

is utilized, and is dissipated through the drains. Electricity, on the other hand, must flow back to the source if we are to utilize its power; hence the circuit — one wire bringing this head of electricity into the house, through the lamps, and back again in a loop to the source.

In this circuit or loop through the house, the chief aim is to make sure that the two wires do not come into contact at any point. If they do, the current will always take the shortest way back to its source, abandoning the rest of the loop and making a "short circuit." Insulation of the wire by means of wrapping it with rubber and cotton braid is one way of keeping the bare copper cores from touching. Moreover, no wire, even though covered with insulation, should come within two inches of another — excepting in a socket, switch, or junction box made for the purpose — without being further protected therefrom by some additional and firmly secured nonconductor, such as a sheathing of metal or composition, or a porcelain tube. It is essential, of course, not only that the wires of the circuit be protected from touching one another, but also that they be protected against contact with any pipes, nails, or other metal that might facilitate a short circuit or a connection with the ground.

Essentials of the Circuit. To return to our simplest lighting circuit of battery (or service wires), wire loop, bulb, and switch: the switch

may be either in the socket of the bulb itself or located at any other point of the loop. A socket is, of course, nothing more than a conveniently detachable connection between the two wires of the circuit and the two ends of the filament. When the bulb is screwed into its socket and the switch is closed, the current flows through the filament, which, by reason of its high resistance to the passage of current, becomes incandescent. A bulb " burns out " and becomes useless when its filament breaks, thus breaking the electric circuit.

Since, in the case of public-service mains, the company must know how much current is used, another element has to be introduced into our simple circuit: the meter. It could be connected at any point of the loop with equal effect for its purpose of measuring the current flow, but it is usually located near where the service mains enter the house. Here, too, is connected another switch (of the double knife type), so that both wires of the circuit can easily be disconnected when the service is not needed, or when any changes in the house wiring, or additions to it, are to be made. Still another element is needed: a fuse — that is, a short section of wire that will melt and break the circuit if a current too strong for the capacity of the wiring should flow through it. The simple circuit for one light has become, therefore, one of six elements instead of three (see Figure 27).

Before discussing the various methods by which the circuit is expanded to serve all the lighting needs of the house, let us look into the details of the essential elements. Starting at the incoming service wires, the fuse plug is the first mystery we meet. As the illustration facing page 154 shows, it is nothing more than a sort of thimble molded of porcelain and capped with a mica window. Through the smaller end of the thimble is one connection: a small copper disc on the outside, to which is soldered one end of the little fuse wire inside. Around the outside of the thimble is a broad band of copper, shaped to a screw thread to engage the whole in a socket. This band has a narrow strip extending from one edge through the porcelain and soldered near the thimble's lip to the other end of the fuse wire. These fuses are made of varying resistances. The two at the service-main entrance will melt at, say, thirty amperes. Those on branch circuits, such as will be later described, will probably be ten-ampere fuses, like the one illustrated. The purpose of

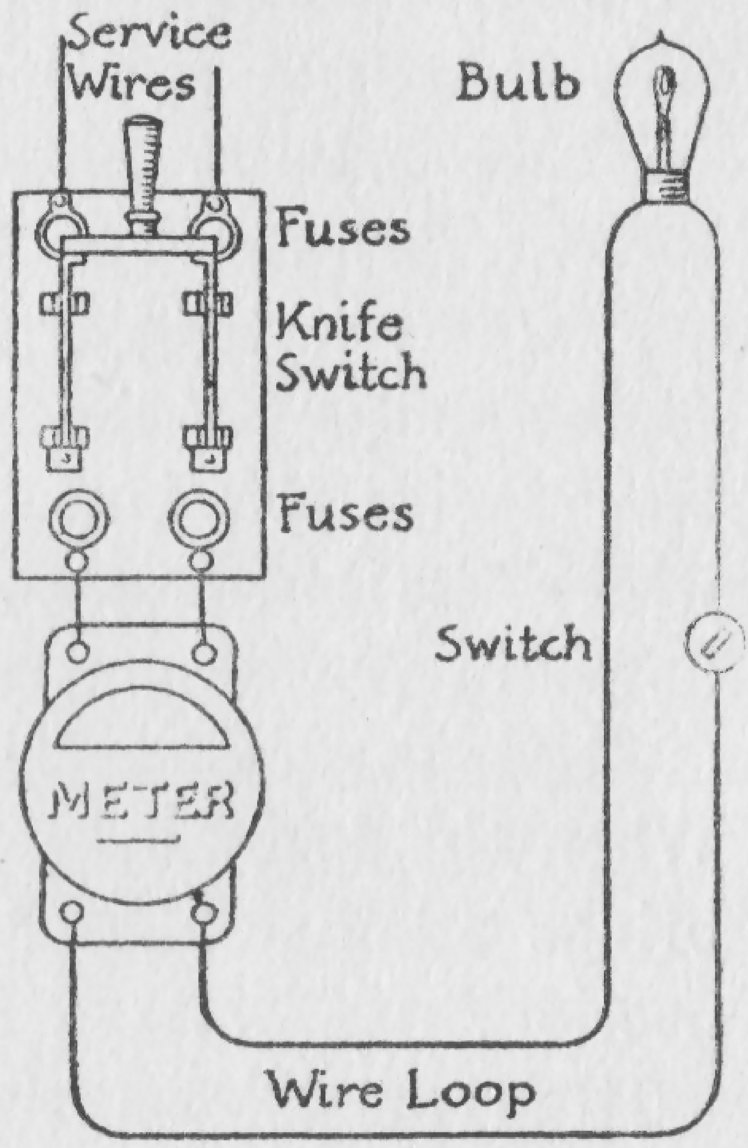

FIG. 27: The essential parts of the simple house circuit.

the mica window is, of course, to enable one to see whether the fuse is burned out or still intact.

The question may arise as to why these fuses are on the service side of the main switch, rather than inside of it. This is to prevent the service mains from being short-circuited in case a piece of wire, a screwdriver blade, or other conductor falls across the switch or its contacts.

These fuses are made also in tubular cartridge form. The principle is the same, but the fuse, instead of having a socket connection, rests in spring clasps terminating the wires of the circuit, one at either end of the tube. For factory use, where the burning out of a fuse means a shut-down in power and consequent loss of time, a multiple form of tubular fuse is often employed. When the fuse burns, a quarter-turn of the tube brings another one of its several units into connection.

It is an all-too-frequent occurrence in most households to discover, when failing lights proclaim a burned-out fuse, that there is not a fresh fuse plug available. A very cheap makeshift, that should be replaced at the first opportunity, is a copper cent. After throwing off the main switch, rest the edge of the cent on the lower flange of the socket so that the top edge of the cent leans back against the central contact. This, of course, makes the connection and gives us light once more when the main switch is connected,

but it deprives the circuit of its very important element of safety, the fuse, and should be regarded as only a temporary expedient. A few extra fuse plugs kept near the switch will provide a means of restoring light in a much better way.

Next comes the main switch — a pair of brass bars held apart by a nonconducting arm and knob or handle. These bars are always hinged at the bottom, so that if left open they cannot possibly fall into the connection slots by gravity. These connection slots are directly connected with the fuse sockets by means of wires running inside the porcelain switch block, and from the hinge ends run similar concealed wires through branch-line fuses to binding posts on the lower end of the block.

With the next element, the meter, we are not particularly concerned. It is a device for measuring current, and is sealed with the service company's seals against any outside interference. All we need to know is that the two wires from the main switch are connected to two of its binding posts, and that two other wires lead from it to form the house circuit.

These wires will vary in size according to the amount of current they will have to carry with all lights burning. Their sizes and the manner of wiring in general are governed by the Code of the National Board of Fire Underwriters. Since there are numerous variations in State and city rules and ordinances, it is always the part of wis-

dom to consult the local authorities before any new wiring or change in existing wiring is attempted. A certificate of inspection and approval is issued, for a fee, by such local authorities; and without this, no insurance will be written on the property. This matter of wire sizes will be taken up in further detail after we see how our simple circuit, supplying one lamp, is enlarged to answer the needs of the whole house.

The lamp itself need not detain us further than to observe that the connecting points — the extended ends of the filament — are the threaded brass band, and the small metal disc in the center of the socket end.

The socket itself will need more study. There are several types: the socket on a drop cord, with or without a key switch, made all of porcelain or of brass over a porcelain core; the socket fixed over a junction box, used in cellar work; the brass-covered, porcelain-core socket used in fixtures, with chain pull; the socket equipped with varying resistance units for dimming; and so on. Some of these are shown in the illustration facing page 176, in which the general principle of connections and insulation is made clear.

Switches, likewise, vary greatly in type, the more common ones (see the illustration at back of the book) being the snap switch; the flush plate switch with two buttons or a tumbler button; and the "three-way switch", which permits

control of one or more lights independently from two points, as in the case of upper and lower hall switches for the hall lights. Practically all interior switches controlling a few outlets are of the type that makes and breaks the connection in a single wire. For larger loads, such as heavy banks of lights, and for branch circuits, the switch is of a knife type that makes and breaks the connections in both wires of the circuit.

Methods of Wiring. There are four methods of wiring in common use: on knob and through tube; through flexible armored cable; through rigid conduit; and in molding of wood or metal. The simplest and least expensive of these is the knob-and-tube wiring, which, however, is not permitted in all localities. The circuit wires are supported on china knobs through which nails are driven to hold them to the framing timbers inside the walls or under the floors. A leather washer is used under the nail head to protect the knob when the nail is driven home. To a row of these knobs, spaced about four feet apart, one wire of the circuit is fastened with a simple hitch loop or by tying it on with an additional short length. Another form of knob is in two sections, between which the wire is gripped when a screw holds both to the woodwork. This is called a split knob. In accordance with the Code, the two wires of the circuit, when parallel, are kept at least five inches apart, each on its own row of

supporting knobs. Where it becomes necessary for one wire to cross the other, or to cross any conductor, such as a water pipe, the wire is further insulated by slipping on it a short section of loom or a porcelain tube. Where the wire passes through studs, floors, or joists, a tube is used, extending the full length of the hole. Again, the wires, where they come together for a fixture outlet or a switch, are covered with a section of loom extending from the last supporting knob. The fixture or switch is supported on a piece of board nailed between adjacent studs or floor joists, and the loomed wires are brought through this board to the metal fixture-canopy covering the hole in the plastering. There the wires running inside the fixtures are spliced to the circuit wires, and these splices are thoroughly covered with both rubber tape and friction tape.

Closely resembling knob-and-tube wiring is the use of porcelain cleats as the supports. These are not unlike the split knobs, in that they grip the wire between two sections held down by screws. The cleats, however, hold both wires, separated by almost the length of the cleat.

The system of wiring through armored cable involves the additional expense of the cable, but saves considerable labor in putting up knobs, tubing the bored holes, looming crossings, and the like. It is rapidly superseding knob-and-tube work. The cable is purchased already filled with

the proper wires — usually two of Number 14 gauge, and is supported by metal-strap fasteners similar to those used for plumbing pipes. It is a system much favored for wiring in finished houses, since it can be fished through walls and under floors without the need of many intermediate supports. The use of armored cable involves, however, the use of iron boxes for all junctions, outlets, and switches. The Code requires that the cable be continuous from outlet to outlet, and that it be fastened securely in a metal fitting at its entry into the boxes. Furthermore, the metal covering of the cable must have a ground connection, to carry off any current that may enter it or be induced in it. This means a simple clamp and wire connected to a near-by water pipe or to an iron rod driven into the ground.

Rigid conduit is iron piping, with walls thinner than those used in water or gas pipes. Here, too, the iron box is used for junctions, outlets, and switches; and the conduit must be cut to proper length, threaded, and secured to these boxes with a bushing inside and a lock nut outside. The conduit and boxes are installed first, the wires being fished through afterwards. This system, too, must be grounded. It is the most expensive of all and, by reason of its absolute and waterproof protection of the wires, is the system least likely to give trouble. Nevertheless, the simpler and

less expensive systems, when faithfully executed in accordance with the Code, are so unlikely to give trouble that one of these is usually employed for house work. In damp places, and for outside use, rigid conduit is used to supplement any of the other systems.

Wiring in molding of wood or metal is rarely employed for new work, even in part, but for additions to existing circuits, particularly where these run in masonry walls, or where concealment is unnecessary, it has a useful rôle. The molding comes in two parts: a backing or base, which is fastened to the wall or ceiling; and a capping. In the molding are two channels for the circuit wires, and the wires are held in place and entirely covered by the capping. The capping is held on by brads in the wooden molding, and by some form of spring catch in the metal molding. There are various special fittings made for crossings, junctions, etc. The molding abuts against a wooden canopy block for a fixture outlet, and the wires are carried into the canopy through two holes bored in the block.

Expanding the Circuit. After this hasty glance at the wiring systems that may be encountered, we may return to the simple circuit that is the basis of all electric lighting systems and follow out the details of its expansion. It is unlikely that the amateur will utilize any but knob-and-tube work or armored-cable wiring, so we may

develop our simple circuit by the former method and follow with an explanation of the few points in which armored-cable wiring requires a different technique.

It would be a great waste of time and a source of endless confusion if any wiring of a lighting system were undertaken before a plan was made of the whole installation. Even when the home craftsman purposes merely a simple addition to existing work, it will be well to put on paper the floor plans in rough sketch form and indicate thereon both the work already in place and that which is to be added. A set of plans is illustrated herewith (Figure 28), simplified by the omission of many other details and showing the location of the various types of outlets and the switch controls. The symbols used on the plans, and explained in the diagram, are those adopted by the National Electrical Contractors' Association and the American Institute of Architects.

It should be borne in mind that baseboards and floor outlets are more easily fed from branch mains under the floor; ceiling and side-wall outlets naturally belong on circuits in the floor above. A careful study of any such wiring problem will make possible the saving of much labor and material by planning the shortest possible circuit.

The first difficulty we meet in enlarging our simple circuit to supply more than the one lamp is a provision of the Code that says no circuit

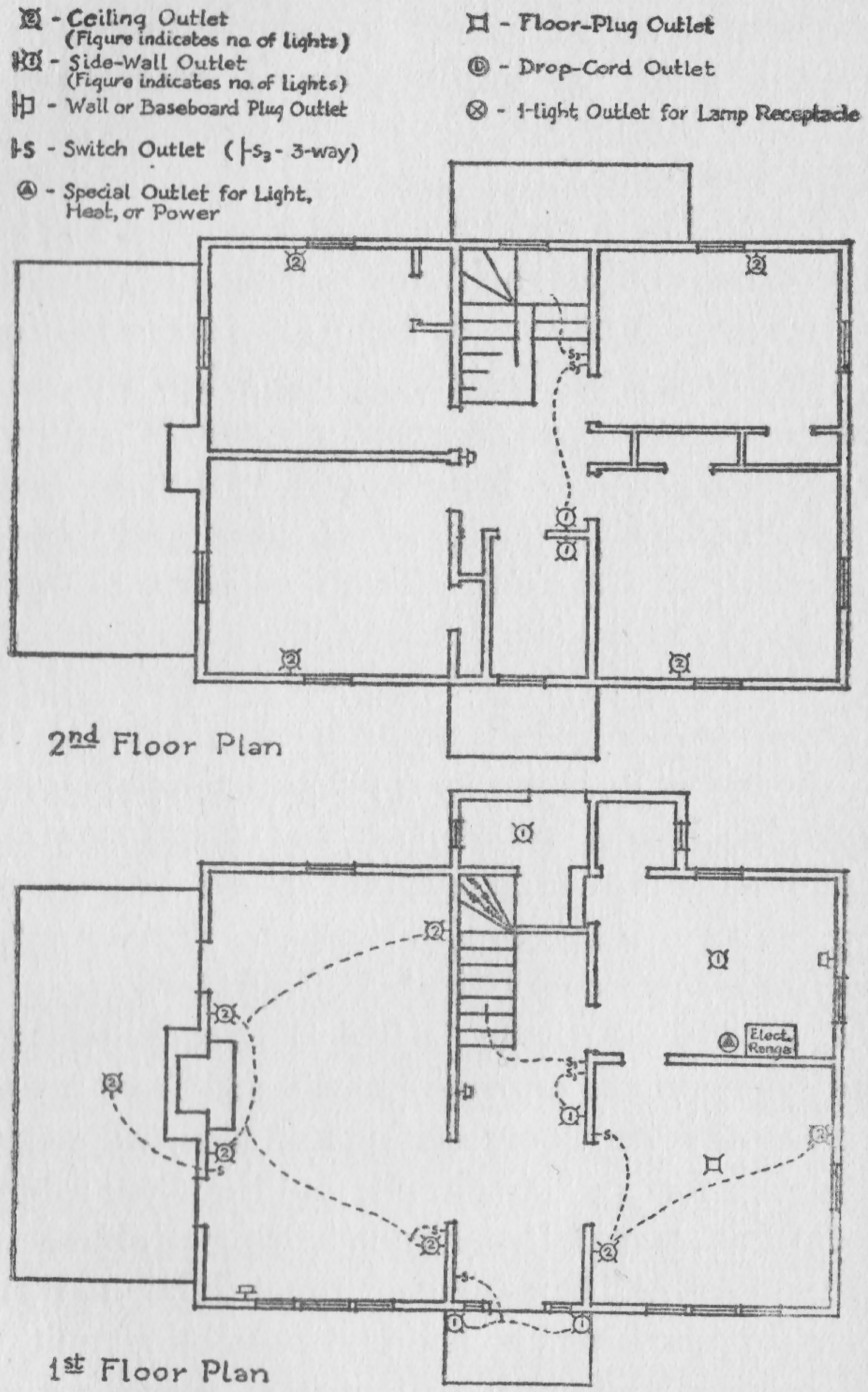

FIG. 28: The customary indication of outlets on the floor plans of a house. The freehand dotted lines indicate which lights are controlled by each switch; when the light is on another floor, as with the hall three-way switches, the dotted line starts up or down the stairway. The standard height of side-wall outlets is 5 feet, 6 inches; of switches, 4 feet.

shall carry more than 660 watts. With the usual voltage of 110, this means that the circuit has a maximum limit of 6 amperes (volts × amperes = watts). Assuming each light to be of 50-watt size, our circuit is limited to thirteen lights, though it is customary to hold it down to twelve. It becomes necessary, therefore, to split our house lighting into as many branch circuits as the total number of lights contains twelve. For these branch circuits, Number 14 gauge wire is the minimum size permitted by the Code. This provides a greater current capacity than is required for our twelve lights, but its mechanical strength is needed for house wiring. Split knobs or cleats must support it. If the circuit has a length of one hundred feet or more, Number 12 wire or larger should be used.

The wires from the public-service source are brought to the upper part of the house, where they enter a rigid conduit, to be led, either outside the wall or inside, to the fuse block, switch, and meter. These are usually in the cellar. Before the feed wires are led in to them, one of the wires is grounded, so that if the transformer at the service company's pole should fail or lightning should strike the feed wires, the high-tension line current (in the first case) or the heavy discharge (in the second case) might pass to the ground rather than into the house system. An iron box (Figure 29) is generally provided for the fuses,

switch, and branch blocks. These blocks are shown clearly in the diagram. After passing through the meter, the two main feed wires are brought back into the box and connected to their

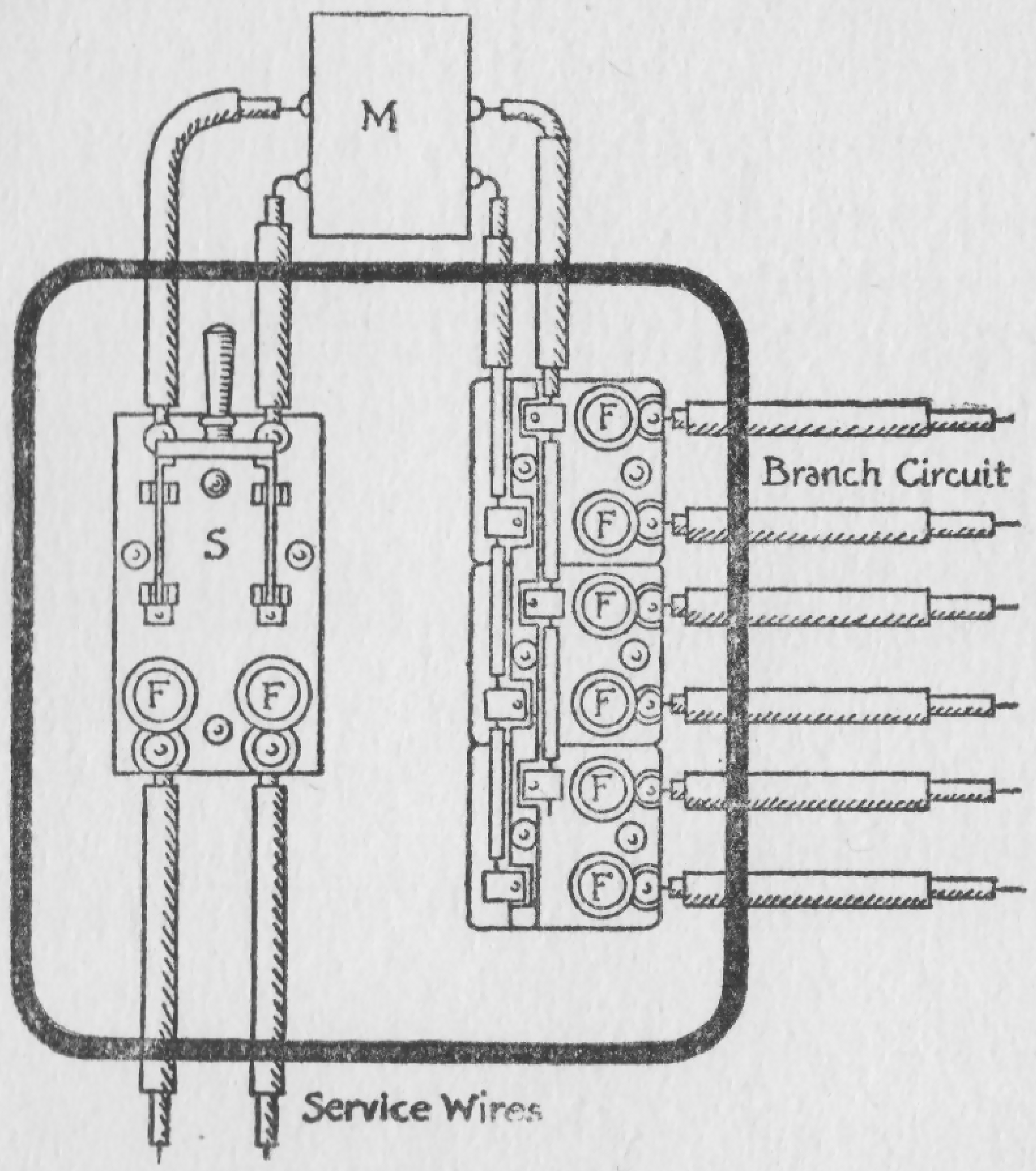

FIG. 29: The service switch and branch blocks are housed in an iron box, usually located in the cellar near the entrance of the public-service wires. The branch blocks are of porcelain, made singly or in groups for two or more branch circuits, and each has its pair of fuse sockets, binding posts, and connecting wires. When knob-and-tube wiring is used, as here indicated, pieces of loom cover all wires in the box and pass through its sides. *S* is the knife switch, *F* a fuse, *M* the meter.

respective binding posts in the branch blocks. Each has its pair of fuses incorporated in the porcelain block.

Branch Circuits. In apportioning the lights throughout the house to their branch circuits,

it should be borne in mind that base-plug or floor-plug outlets that are to be used for electric irons, toasters, vacuum cleaners, and similar accessories, will use more than the fifty watts that we have allowed for a lamp average, and the circuits that feed them will need to be correspondingly restricted. An electric iron uses from 300 to 600 watts; a toaster about 550; a vacuum cleaner about 200; an electric heater about 600-660 watts. It is apparent, therefore, that the circuits likely to feed such conveniences may well be confined to the outlets so used. As a vacuum cleaner will not ordinarily be used on more than one baseboard outlet at once, the circuit might supply all the baseboard outlets, unless there is a possibility that a heater or iron may be used at some other outlet on the same circuit while the vacuum cleaner is in use. If this should happen, it would merely burn out a branch-circuit fuse.

It is apparent that the main feed wires and the main knife switch will have to be of such a capacity as will carry the total current in all the branch circuits. The capacities of the more commonly used sizes are given by the Code as follows:

Wire Gauge	Amperes with Rubber Insulation	Amperes with Other Insulation
8	35	50
10	25	30
12	20	25
14	15	20

The flexible cord used for portable lamps, having baseboard or floor-socket connections, is made of two groups of Number 20 gauge wires, each group insulated and the two wound with cotton, rubber, and an outside winding of cotton thread or silk. By the twisting of more or less of these small wires together, the capacity of the strand is brought to the desired point, corresponding to the regular gauge Numbers 10 to 22. These twisted strands are less likely to break, through repeated bending and kinking, than is a solid wire of the same capacity.

Wiring Practice. The splicing of wires and the tapping of a circuit to reach an outlet call for a junction that affords a perfect connection electrically, a connection that is mechanically as strong as the wire itself, and an insulation over the junction that is no less effective than the regular insulation. Spliced and taped joints are shown in an illustration at back of book, where it will be noted that the twisting of the wires is left rather open over a portion of the joint, so that the solder, which is a necessary accompaniment, may find its way between the wires and form a good electrical contact. Three inches are stripped of insulation on each end to be spliced. For the tap, two inches are sufficient to bare the main wire, and three inches for the tap wire.

For the soldering operation, the gasoline torch, such as is used to burn off old paint, is the best

source of the necessary heat. To light the torch, fill it three quarters full of gasoline, pump up the air pressure in it, then hold the palm of one hand over the nozzle and open a little way the valve just back of it. Gasoline will be forced through the side holes of the nozzle into the drip cup underneath. When this is nearly full, close the valve, and then the other hand need no longer be held in front of the nozzle. Touch a lighted match to the gasoline in the drip cup and allow the gasoline to burn, shielded from draughts, until the nozzle is well heated. This will require the burning of practically all the exposed gasoline. Before the gasoline has been entirely consumed, open the valve again slowly. A blue flame should be projected from the nozzle. If the flame is not blue, the nozzle is not sufficiently heated. Holding the flame fairly close against the ground will drive it back on the nozzle and complete the heating. The pump handle will have to be worked occasionally to keep up the necessary pressure.

To solder a joint, apply a little soldering paste, which may be bought ready-prepared, to the joint. Heat the joint with the point of the blue flame until it will melt the solder when held against it. Avoid overheating the wires, as this makes the joint brittle and weak. The solder is used more conveniently in the form of wire than in the bar.

After the solder fills and covers the joint, wind a piece of rubber tape upon it from one insulation

to the other. The solder will probably be warm enough to vulcanize this rubber to itself, if the tape is pressed close with the fingers. On top of this, wrap friction tape to make the insulated joint somewhat thicker in diameter than the insulated wire itself.

Occasionally it becomes necessary to solder the end of a stranded or solid wire into a metal lug for a terminal connection. The Code requires this, or the use of a special solderless terminal connection where wires larger than Number 8 are used. To solder the wire into one of these lugs or hollow caps, the wire is first cleaned of its insulation far enough just to reach the bottom of the lug. Heat the lug in the torch flame until it will melt solder held to its open end. Fill the lug about three quarters full of the melted solder. Dip the wire into soldering paste and insert it in the lug. Remove it at once, to make sure that it is completely tinned. If its surface is not covered with the solder, it may be because the wire is not clean. When it is fully tinned, insert it again and allow the solder to cool about it. Transferring the hot lug from the pincers to a wet cloth held between the fingers will hasten its cooling.

An important point in wiring is to arrange the circuit so that the lights are connected "in multiple" (Figure 30) rather than "in series" (Figure 31). In other words, each light on the

circuit should be fed directly from both sides of the circuit and not through other lights, else when one of these lights is turned off or broken, the whole series will be out of commission. Moreover, series wiring requires a higher voltage with each lamp added. Each switch, obviously, must break one of the tapped lines extending from the main circuit wires to the lamp that is to be

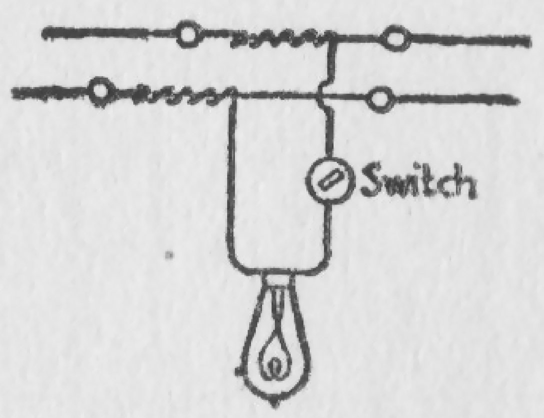

FIG. 30: All lamps are connected "in multiple" by branch lines from each side of the circuit. The switch is placed at any point on either branch.

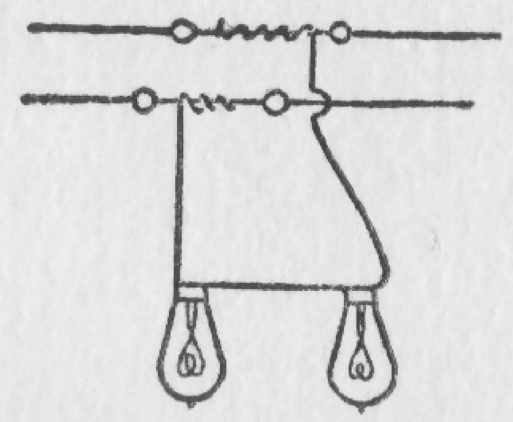

FIG. 31: Two lamps wired "in series" — the wrong way, since the voltage is thus divided, and the burning out of one bulb automatically cuts out the other.

controlled. Either side will do, but the switch must not break the main circuit unless that is its particular purpose.

Three-way Switches. For the control of a light at two different points, such as the usual hall-light arrangement, so that it may be lighted or put out either upstairs or down, the three-way switch is used. Figure 32 shows the connections for lights in upper and lower halls, each controlled at two points. The three-way switch has three binding posts. Where the three-point switch is not available, a four-point type can be employed;

two of its posts are connected across with a short wire to correspond with post A on the three-point form. From the opposite two posts two wires are run to two points in the other switch. The switches so joined are then treated as a single switch; that is, the tap wire from one side of the

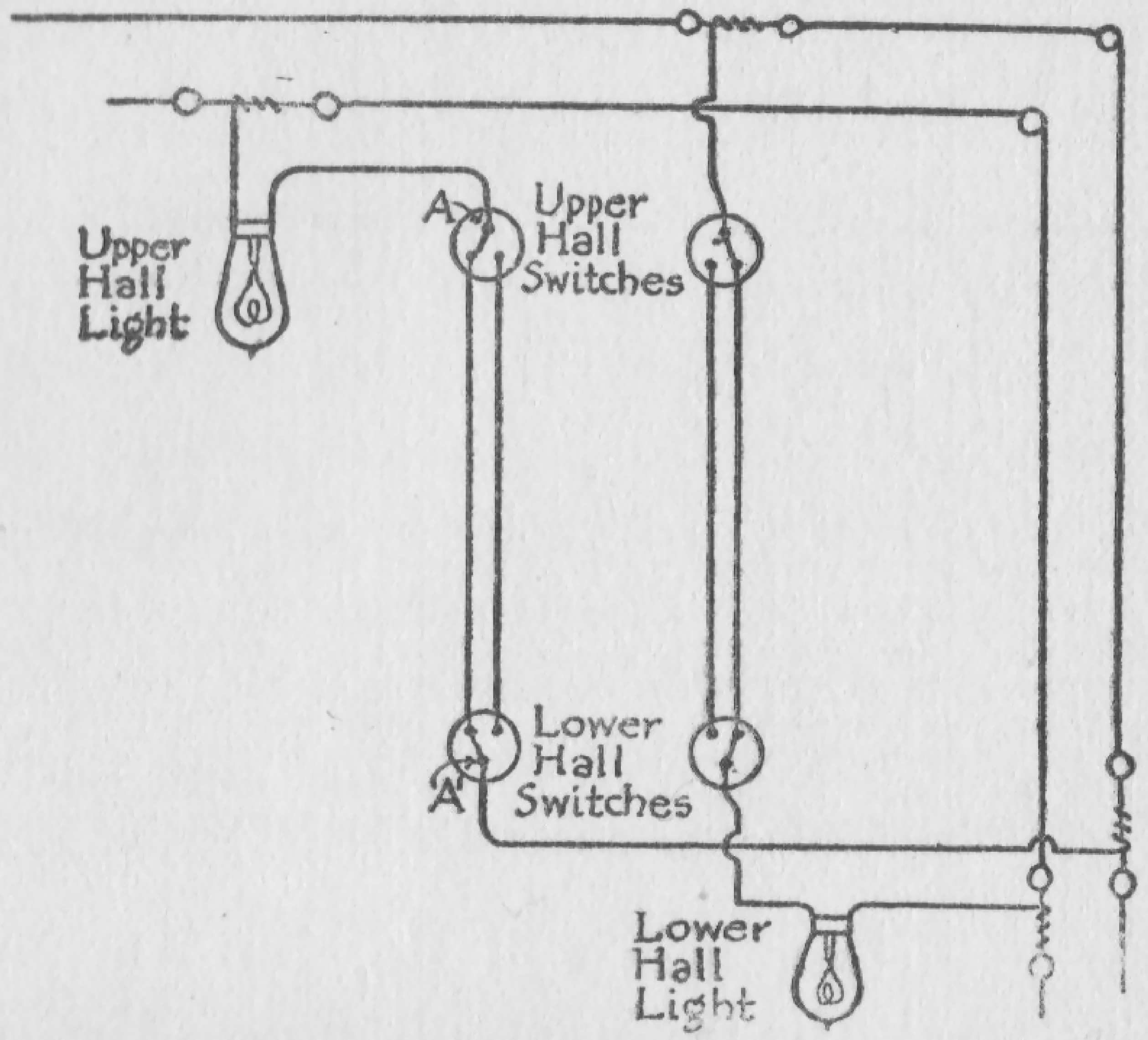

FIG. 32: The usual knob-and-tube wiring for upper and lower hall lights, each of which is controlled through two switches. A pair of wires joins each upstairs switch with its mate below; otherwise, the pair is treated as a single switch with poles A and A'.

circuit is run to the light and thence to post A, and a wire from post A' of the other switch is run back to the other side of the circuit. In each switch, a bar, pivoted at A and A' respectively, may be snapped from one of the opposite posts to the other. In the diagram, these bars are shown in a position that leaves both lights lighted. Snapping either of the switch bars to the opposite

connection will break the circuit; then snapping the other switch will close the circuit again through the other wire of the parallel pair.

Outlets. Side-wall outlets, whether for fixtures or for switches, are supported by a board nailed between the studs. The circuit wires or switch wires are brought to knobs near-by and run thence through loom into the outlet box or switch box. If the outlet is for a switch, it is easier to nail two parallel strips between the studs and screw the projecting top and bottom flanges of the box to these. The fixture outlet (Figure 33) is a round iron box with a central stud threaded for a pipe that forms the skeleton of the fixture under its brass tubing.

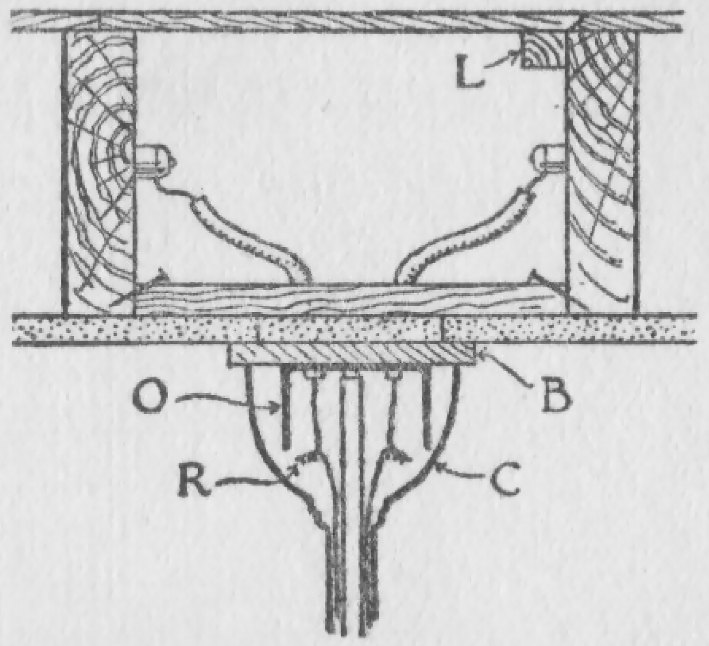

FIG. 33: A section through floor and ceiling, showing the wiring for a ceiling fixture. In the flooring above, a pocket has been cut, and then the flooring has been replaced on the new ledge L, as explained in the text. A board has been nailed between the joists, just above the lath and plaster. Into this board the canopy block B is nailed or screwed, and to the block is fastened the iron outlet box O. (Often this box is fastened directly to the board between the joists and the canopy C rests directly against the plaster.) The circuit wires are usually joined to the fixture wires by rat-tail joints inside the canopy, as at R, the joints being covered with friction tape.

Wiring in Old Houses. In an old house, the work of new wiring is made more difficult because the walls are already plastered and the joists covered by the flooring. The work is done, however, without materially damaging the existing walls or floors, by the well-known scheme of "fishing." Holes are cut in the plaster for the neces-

sary outlets; and after the wiring is in place, the outlet boxes are screwed to the laths (Figure 34). A short section of a floor board adjoining the wall above or below the outlet is sawed out (as will be described); or if the wall is a partition wall, it is better to remove the baseboard, as the partition studs usually rest upon a horizontal timber that would block access from the floor pocket. In removing the baseboard it is easier to drive the nails in through the board with a small nail set, as an attempt to pry the board off will probably split it.

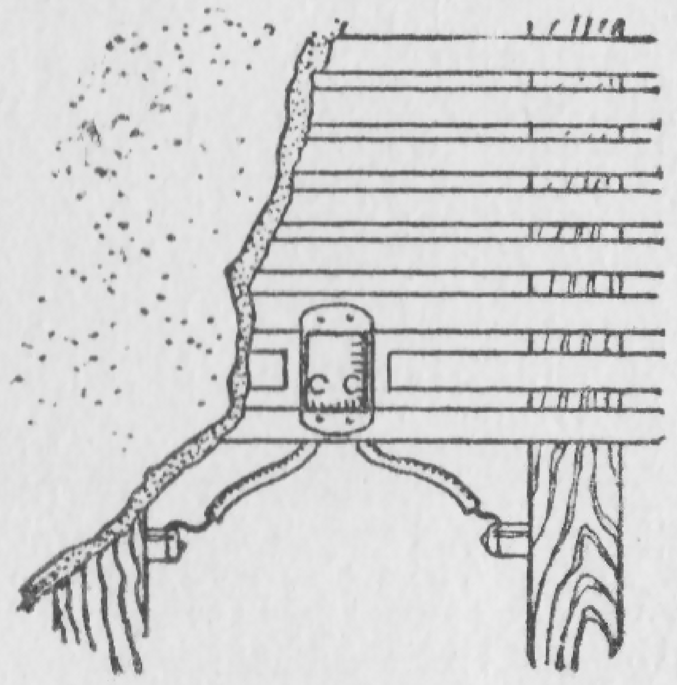

FIG. 34: A side wall cut away to show the outlet box for a switch, fastened to the laths. The wires from the near-by knobs, on the sides of the studding, are incased in pieces of loom extending into the box. The outer face of the box is set flush with the plaster and covered with the switch plate.

For opening a floor pocket, select a board that ends near-by and cut off the tongue on both sides by driving down a putty knife through the cracks. Cut these tongues off to the nearest joist — the end joint of the board will be over one joist for nailing. Saw across the grain as close to the joist as possible, beveling the cut so that the top surface of the board will be longer than the lower surface (Figure 33). Some workmen bore an auger hole to start the keyhole saw in; but with careful use of a sharply pointed saw, the cut can be made without this hole, and the floor will not

be materially defaced. In putting the board back, put a sheet or two of cardboard into the slot made by the saw, and nail a strip on the joist to support the short length.

Where the wires have to be run through a row of joists by boring and tubing, two boards will have to be taken up for their full length across the floor. As will be seen in Figure 35, the boring of

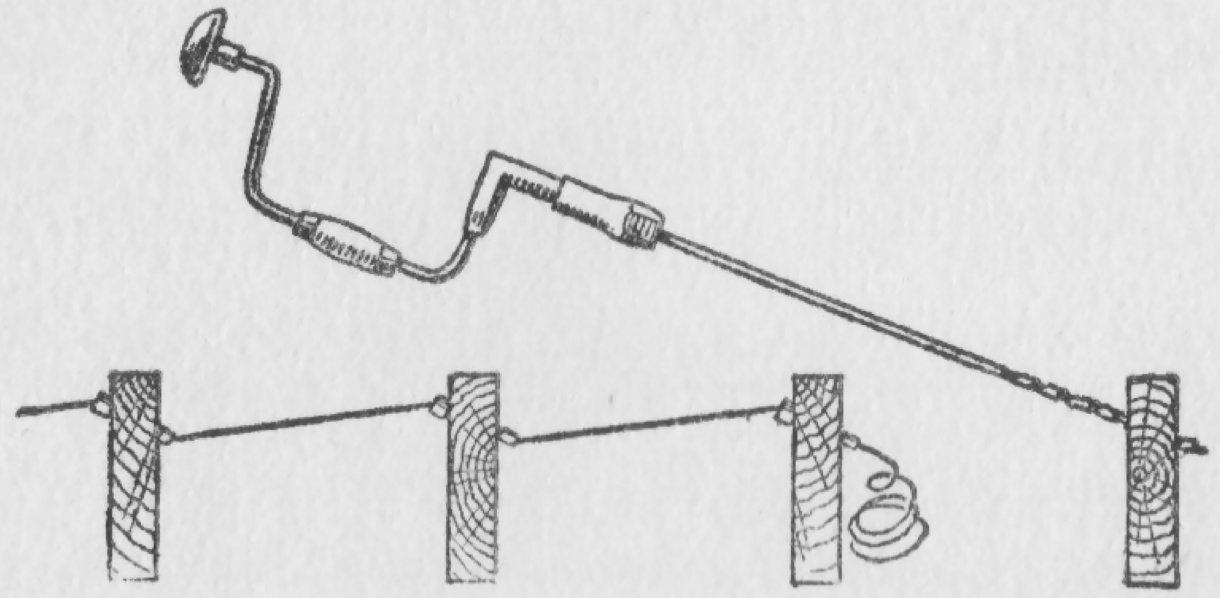

FIG. 35: In knob-and-tube work, a wire running at right angles to the floor joists passes through holes insulated with porcelain tubes. A long $\frac{5}{8}$-inch auger bit is needed.

the joists for tubes must necessarily result in a series of holes that are at an angle from the horizontal. An extension rod, fitting between the brace and the auger bit, will prove a great convenience in this work; or a bit made longer than the usual carpenters' bit may be had for electricians' use. The $\frac{5}{8}$-inch diameter is the one used for ordinary tube boring. As the diagram indicates, the head of the tube should be at the end that will hold it in the bored hole by gravity, and that, when the wire is tightened up after it has been threaded through, will keep the tube from

getting out of place. Where a tube occurs that is not held in place securely by reason of its position, as when passing another wire or pipe, it can be held in its place by a wooden wedge.

Where wires pass through a floor and inside of a wall or partition, the tubing must not only be long enough to go through the floor, but also extend for four inches or so higher, as a protection against plaster that might fall down about it behind the lath.

The actual fishing through of wires is done by lowering a small weight, called a "mouse", on a stout cord from the upper point to the lower. The wire is then fastened to the upper end of the cord and drawn down through the wall to the lower opening.

Testing. After the wiring is in place, it should be tested both for open and for closed circuits. The electricians use a bell and a hand-driven magneto for testing, but the amateur may find it more convenient to use a bell and a battery. This is hooked up at the branch-block ends of each circuit. If the bell rings, a short or closed circuit is indicated. To test for an open circuit, hook up the bell and battery in the same position and touch together the ends of the wires at each successive outlet. If this does not ring the bell, the circuit is open at some point in between. If the outlet boxes and sockets are already in place, screwing in a fuse plug will make the necessary connection for this test; or the blade of a screwdriver may be held across the flange and back center of the socket.

Armored Cable. Two spiral windings of metal tape form the very popular insulation that is used in the system of wiring known by this name. The cable is also known as "BX." When it is further reënforced by a thickness of lead between wires and the spiral windings, it is known as "BXL cable." This additional insulation is used for damp locations or for outside work, though rigid conduit is usually preferred for such places.

Where the cable enters an outlet box or junction box, the armor is held by a clamp and bushing as has been explained; and perhaps six or seven inches of the inclosed wires will project into the box for connections. As the cable is purchased already loaded with the wires desired, the armor must be cut away at the junction points. A hack saw does this readily. The cut should not, however, be carried through the armor wall, but just far enough so that the armor may be broken by bending it back and forth. Saw it at right angles to the length, not in line with the spiral winding.

A $\frac{3}{4}$-inch bit will bore the right-sized hole for passing armored cable through studs, floors, or joists. Comparatively few supports are needed for the cable, as compared with knob-and-tube

wiring, and these are the galvanized iron straps used for supporting pipe, held against joists or studs by two nails.

A commonly used type of box employed for junctions or outlets has five holes for the entrance of cables. These holes are closed by thin plates when the box is purchased, and only as many holes as will be needed are punched out before the box is fastened in place.

Systems Other than Two-wire. Everything that has been said in this chapter is based on the use of the two-wire system — that is, two wires entering the house from the public-service mains, or from a battery. This is the system most commonly employed, whether the current is a direct or an alternating one. These two wires almost always have a difference in potential of 110 volts.

Other systems are occasionally found using three wires or even four. These systems will not affect much that has been said in these pages, for the additional wires will extend no further than the branch blocks, excepting where power lines are carried direct to an electric range or ironer, and metered separately at a lower rate. Throughout the house from the branch blocks, the two-wire system will serve. The problems that arise in the meter connections and main switch with these other systems are so rarely encountered that they need not be discussed here. The company furnishing the current would in any case make

clear the principles involved and the connections made necessary.

Any consideration of electric lighting fixtures would fall outside the scope of this book. It may be helpful to the home craftsman, however, to know that the familiar dull brushed brass of fixtures and flush switch plates, which becomes tarnished in time, can be restored to its original brilliance without great difficulty. The lacquer finish is removed by rubbing it with denatured alcohol and a fairly coarse powdered pumice — say, Number 2 — and with it comes the discoloration. A fresh application of lacquer will prevent the more rapid tarnishing that occurs with brass surfaces not so protected. This means of removing the lacquer is suited to brushed brass only; a bright brass finish would be scratched by the pumice.

THE ELECTRICIAN'S TOOLS

Assuming that the amateur will not undertake wiring with rigid conduits, for the fitting of which a pipe vise and threading, cutting, and reaming tools would be needed, the following tools should equip him for wiring with knob-and-tube and armored cable, and for the bell work to be described in the following chapter:

Zigzag rule, 6 feet

Pair of 7-inch side-cutter pliers

Ratchet brace with long bits of $\frac{1}{4}$-inch, $\frac{5}{8}$-inch,

and $\frac{3}{4}$-inch diameter (or an extension bar for the shorter bits)

Adze-eye hammer, 1-pound
Keyhole saw, 12-inch
Hack saw, 10-inch
Putty knife
Jackknife
Automobile wrench, 8-inch
Screwdrivers, 3 sizes
Star drill for brick or concrete, $\frac{3}{4}$-inch
Gasoline torch, 1-pint
Soldering iron
Twist drills, $\frac{9}{64}$-inch, $\frac{11}{64}$-inch; and taps, 8–32, 12–24 (for drilling and tapping threads in metal boxes for machine screws)

CHAPTER XIV

Bell Wiring

As compared with wiring for electric lighting, the installation of signal circuits is mere kindergarten work. There is no formidable Code to govern what we may do or what we must avoid, for the current employed is so weak as to be incapable of doing any damage to property or person. One important proviso is to be made: signal circuits must be kept well separated from wiring for lights or power.

There is but one way in which the two have any connection, and that is when we want to do away with batteries and employ the heavier voltage of an alternating-current lighting circuit, stepped down through a transformer made for the purpose. A transformer of this type has four binding posts, two of which are connected to the two sides of the lighting circuit, the other two being connected to the signal circuit in place of the battery.

In the simple signal circuit, the current flows from one post of the battery (or transformer) to the bell, thence to the push button, and from this

back to the battery. The push button is, of course, merely a switch that is closed by the pressure against a contact spring.

The batteries used in modern work are usually of the dry-cell type, of which two kinds are carried in stock by electrical dealers: one for automobile ignition and one for open-circuit bell work. Since these cells deteriorate even when not in use, they should be tested with an ammeter and show at least twenty amperes of current before being accepted. A cell showing less than five amperes is worthless for signal work.

Three of these cells will ordinarily be required for the few bells or "buzzers" used in the average house, and they will probably need to be replaced after two years' service.

In connecting up several cells to form a common battery for the several circuits, short wires are cut to join the intermediate opposite poles, leaving a pair of opposite poles for the circuit wires. In other words, connect a zinc binding post (on the rim of the cell) with the carbon post (center) of the adjoining cell; connect the zinc of the second cell with the carbon of the third; and so on. This leaves the first carbon post and the last zinc post for the main circuit connections.

The vibrating bell used in signal work consists (Figure 36) of a pair of coils C; an armature A, on the end of which is the clapper; a contact screw S; the gong; and two binding posts P and

P'. When the battery circuit is closed by the push button, the current flows in at P', through the coils to S, through a contact spring on the side of the armature, and back into the circuit through P. As the current flows through the coils, their iron cores are magnetized and draw to them the armature. This movement of the armature breaks the contact at S, stopping the flow of current and therefore ending the magnetic pull of the cores. Thus released, the armature returns, by spring action, to its original position, making the contact again at S, and then repeats the jump across to the coil cores. This action continues so long as the push button keeps the battery circuit closed. A buzzer acts on precisely the same principle, but has no gong nor any clapper as an extension to the armature. The movement of the armature itself, making its contacts, produces the sound.

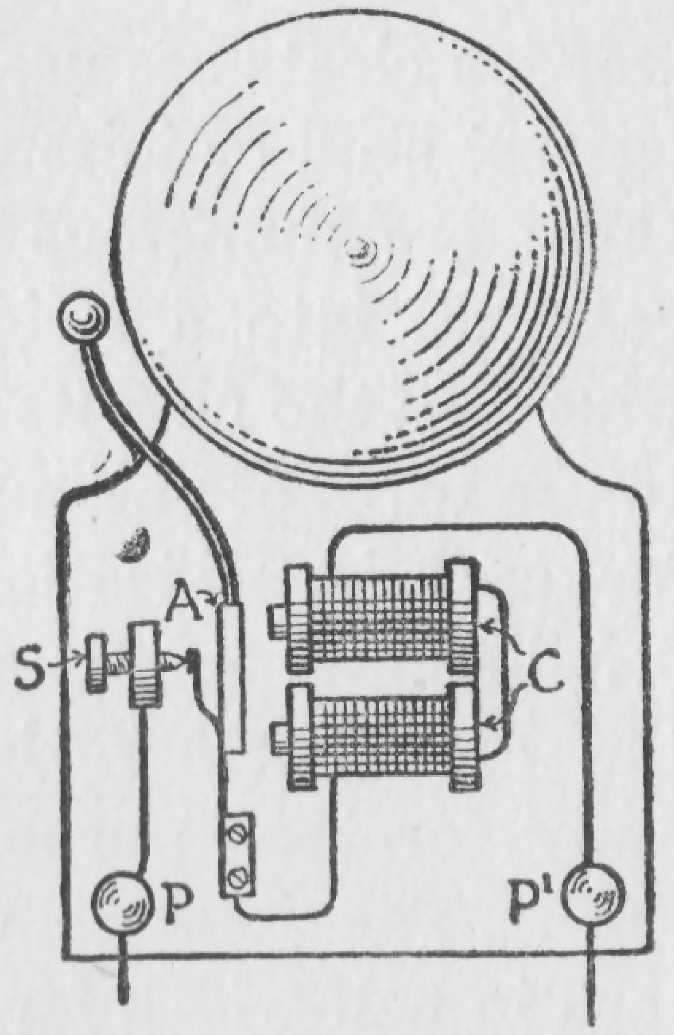

FIG. 36: The common type of electric bell. P and P' are the binding posts for the circuit wires; C indicates the coils; A is the armature with clapper attached; S is the contact screw, making and breaking the circuit against the little spring on the side of the armature. This armature itself is fastened to a spring at its bottom end.

Bell wire has a double insulation of cotton, impregnated with paraffine. It is supported against the surfaces of studs or joists by small

staples or double-pointed tacks. Naturally, the same staple must not support both wires of a circuit, nor should the staples of parallel lines touch, on account of the danger of short-circuiting if the staple abrades the insulation. Sometimes wooden cleats are used, holding two or more wires against stud or joist with a single nail. Or, when there are numerous wires, these are sometimes gathered into a rigid conduit. In this case, or wherever the circuits are complicated, it is a help to use wires of variously colored outside insulation for quick identification.

Joints and splices are made by tightly twisting the wires together, the insulation having been cut away for that purpose. Soldering is not necessary. The joint is wrapped with friction tape, torn in half-width for greater neatness.

When one wire crosses another, it should have a wrapping of tape. Passing through studs, joists, or plaster is accomplished by boring a hole with the $\frac{1}{4}$-inch bit, and the one hole will suffice for several wires without additional insulation.

In the simplest bell circuit, with a push button at the front door, a battery in the cellar, and a bell in the kitchen, the obvious course would be to run one wire from push to bell, one from push to battery, and one from battery to bell. Frequently, however, it is possible to save a considerable length of wire by connecting to the plumbing pipes for one side of the circuit.

When several bells are grouped together and controlled by different push buttons, one wire is run from the battery and tapped to one post of each bell. It may be possible, also, when two or more of these push buttons are near together, to connect one post of each to the corresponding posts of the others and run one wire for all to the battery, or to the plumbing and thence to the battery.

When two or more bells are to be operated simultaneously from one push button, they should

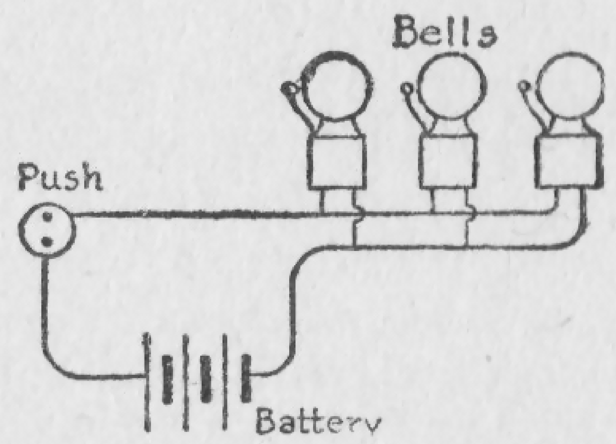

FIG. 37: Three bells controlled by a single push button and connected in multiple; that is, so that each bell receives its current directly from the circuit.

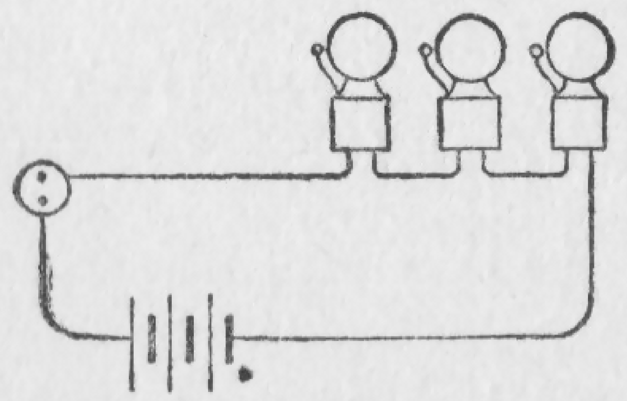

FIG. 38: Three bells wired in series. When this is done, one bell is made the "master bell", making and breaking the circuit for all three, the others being short-circuited through the contact screw (shown at *S* in Figure 36).

be connected in multiple (Figure 37); that is, so that each receives current independently of the other. Or, if the bells are connected in series (Figure 38), it is better to allow only one bell (the "master bell") to act as the make-and-break for the group. This is done by short-circuiting the screw *S* to the spring of the armature on each of the other bells. Otherwise, since the periods of vibration are hardly ever precisely alike, the

make-and-break will not synchronize and the results will be most uncertain. This plan of connecting in series requires, however, an increase in battery voltage.

A common problem in signal wiring calls for a bell rung in the garage or stable from a push in the house, together with an answering bell in the house, controlled by a push in the garage, to show that the first signal has been heard. Two wires between the distant points (or one wire and a

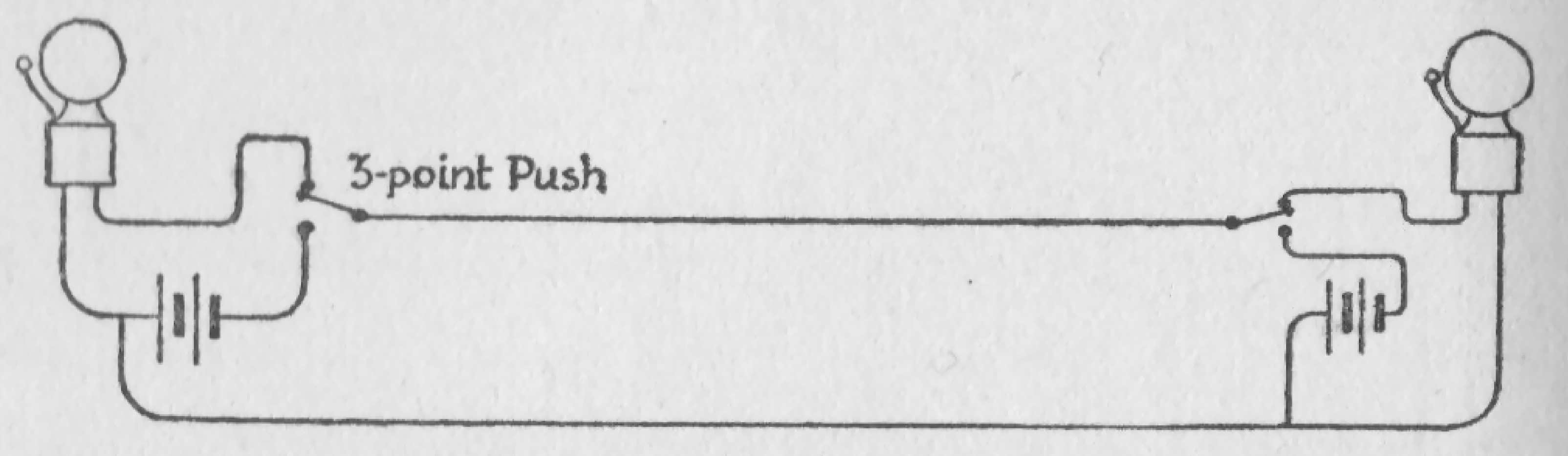

FIG. 39: A scheme of wiring a call-and-return signal system so that but two wires are needed between the stations. The push buttons are of the type that forms one contact when not pressed and another when the button and spring bar are depressed. Two batteries are needed.

water pipe) will serve for both circuits if arranged as in Figure 39. Two batteries are needed — say, of two cells each; and the push buttons are of the double-contact type. The spring bar is in contact with an upper connection, excepting when the button is depressed to break this and make another connection below. The diagram indicates that the spring bars in both switches are joined by one of the long wires, and that the lower contacts of both are joined to their respective batteries.

When there are no more than three bells and a buzzer in the kitchen, it is possible to differentiate the sources of the signals by different tones in the bells. An increase beyond this point in the number of stations calls for an annunciator. Here, too, as with the bell and the buzzer, the small coil and its magnetized core are made to serve us.

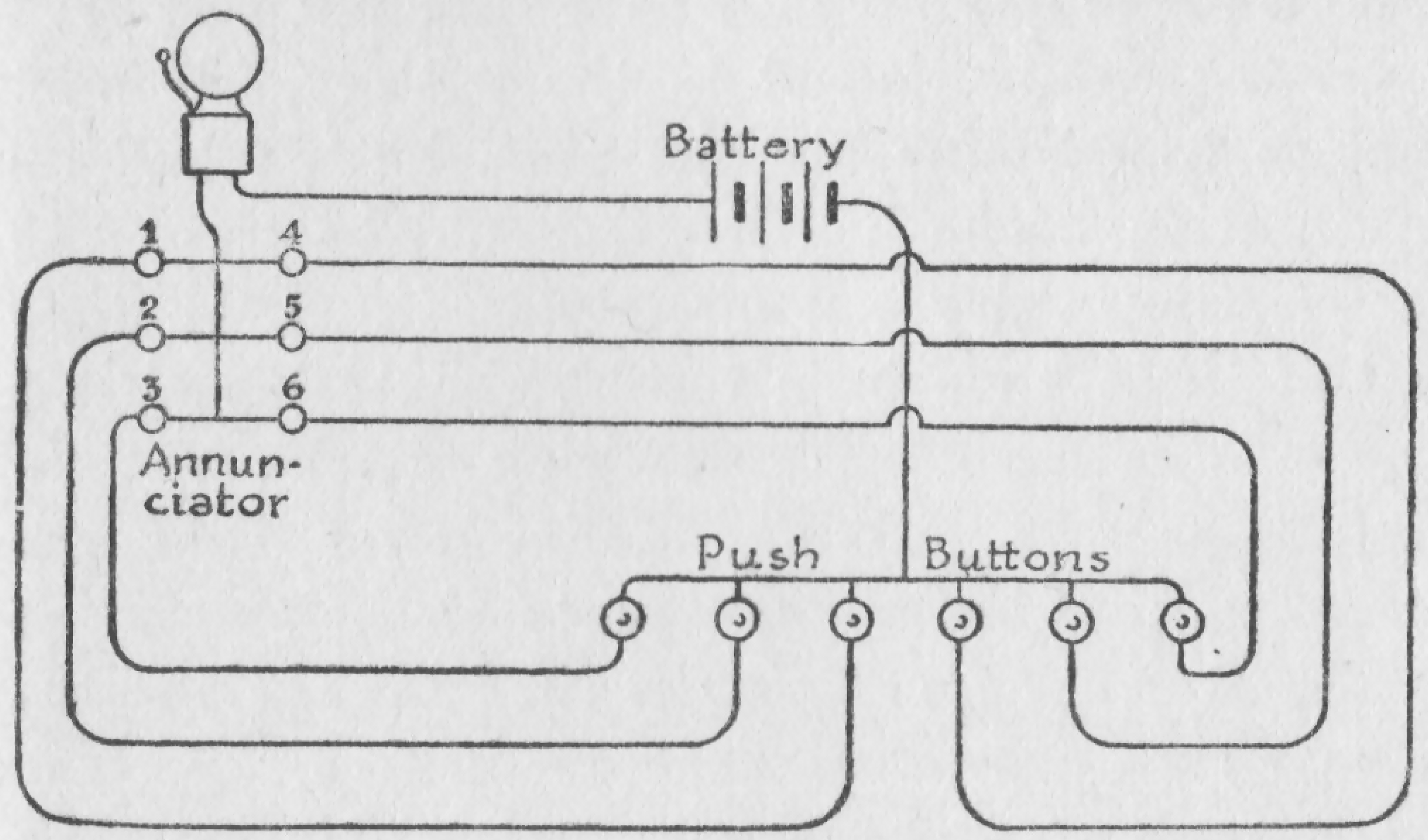

FIG. 40: In the wiring for an annunciator system, a single wire connects one post of the bell with the battery, and another runs from the battery to one side of all the push buttons. The other wires must connect each push with its corresponding signal drop in the annunciator.

There are two types of annunciator: in one, a needle is attracted from its normal position by the flow of current through a coil near by; in the other, the coil core attracts the armature and thus trips a numbered or lettered drop into a visible location. With either type, the annunciator may be reset to its normal state by a push rod. The wiring for such a device needs no explanation other than Figure 40.

Testing for Trouble. When a bell system fails to work, the first point to test is the battery. Try out each cell by connecting a bell or buzzer across the two posts. Perhaps only one cell of the group may prove useless, in which case a new one should replace it; but if one cell has failed, it is likely that the others will not last much longer, and a whole new set may as well be put in.

If the trouble is not in the battery, the next things to examine are the push button and its connection. The bell itself should be tested by connecting a dry cell directly to it. Only after all of these have been tested, should the circuit wiring itself be examined; for of all the parts of the system, it is the least likely to become broken.

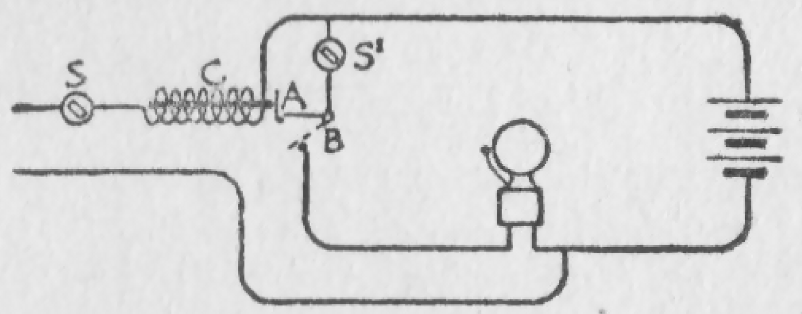

FIG. 41: The open-circuit burglar alarm. *S* is the switch closed at night to put the system in service. *C* is a magnetic coil. This, when current flows through it, attracts the armature *A*, tripping the bar *B*, which drops upon a lower connection and closes the local bell circuit. Switch *S'* serves to stop the ringing of the bell. The wires passing off to the left join all the door and window switches.

Burglar Alarms. The system most commonly employed for a burglar alarm in the house is the open-circuit system (Figure 41). Two forms of switches are used, one for the doors to be protected, the other for the windows. The door switch is a spring contact set in the jamb. When the door is closed, the contact is held open; and when the door is opened, the spring is released to make the contact and ring a bell on the regular battery circuit.

For the windows, another shape of switch works in the same way.

Without some provision for continuous ringing, the first sound of the bell might prompt the burglar to close the window or door and thus break the circuit before the warning had continued long enough to awaken the household. To prevent this, the magnetic coil is again employed. The circuit being closed at any door or window switch, the current flows through the coil, and the coil attracts the armature. The armature trips a small lever, and this drops upon a connection to form its own independent closed circuit to ring the bell, which continues ringing until some one opens the master switch indoors. This system requires another switch between coil and local switches — one that can be opened in the morning to nullify the window and door switches during the hours the alarm is not needed. When it is thrown on, the last thing at night, it provides a test to show whether all doors and windows are closed.

The form of this window switch is such that provision can easily be made for keeping bedroom windows partly open. A depression is cut in the edge of the sash, and the switch is set in the jamb at a point that will be opposite this depression when the window is opened the desired amount. Opening the window an inch or two further will depress the switch into contact.

Another system of wiring for burglar alarm provides a closed circuit instead of an open one. With the addition of an elaborate annunciator, this is the one in use for the protection of business offices and warehouses. Since current is flowing constantly through this circuit when the main governing switch is closed, the ordinary dry cell battery will not serve. A liquid type, called a "gravity" battery, is designed to meet the needs of the closed circuit.

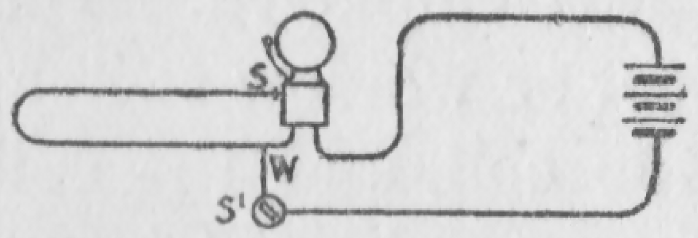

FIG. 42: The closed-circuit burglar alarm. One wire of the loop at the left is connected to the contact screw *S* (see Figure 36), magnetizing the coils so that they hold the armature and clapper. In the loop at the left are connected all door and window switches. The circuit, when any one of these switches breaks it, becomes a common vibrating bell circuit through *W* and rings the alarm. *S′* is the night switch.

Figure 42 illustrates the wiring. In addition to the usual circuit of battery, master switch, and bell, a wire leads from the contact screw *S* through the various windows and doors — which, when closed, close the circuit — and back through the main switch to the battery. The night switch being closed, current flows from the battery, through the coils of the bell, to *S*, and back through the whole series of alarm switches to the battery, thus magnetizing the coil cores and holding against these the armature and bell clapper. This action prevents the usual make and break of the regular bell circuit. The opening of a door or window, or even the cutting of the wire at any point, breaks the circuit; the clapper is released, and the regular vibrating bell action occurs. Closing the door or window will quiet the bell — a fault that can be remedied by further elaboration of the wiring with a trip contact, somewhat as in the open-circuit system.

CHAPTER XV

Masonry

It is a curious fact that while nine men out of ten will tackle any simple job of carpentry or painting or electric wiring, most of the nine will acknowledge helplessness and call in a mason when confronted by even the simplest task that calls for mortar and trowel. Yet the work of the mason certainly requires less skill, less knowledge, and less experience on the part of the novice than does any of the above trades excepting, perhaps, electric wiring, which, with a little knowledge, is the easiest of all.

It is said, apparently on excellent authority, that in 1922 there were more multimillionaires in the United States than there were plasterer's apprentices. The growing use of substitutes for plastering, substitutes that are bought more or less ready-made and can be put up by the carpenter, is undoubtedly a result of this situation. Bricklayers, too, are far too few in number for the enormous demands made upon the trade in the present era of extensive building, while the

stone mason is becoming nearly as much a rarity as the traditional great auk.

Workers in concrete are fortunately more nearly equal to the demand, largely because, with proper supervision by one who knows, most of the work is rightly classified as "unskilled". Nevertheless, much of the unsatisfactory concrete in this country is directly traceable to the legendary belief that anyone, given cement, sand, stone and water, just naturally makes good concrete.

After the amateur craftsman has undertaken some one of the simpler masonry jobs that frequently present themselves at home, he will discover for himself that there is nothing inherently difficult in this work, particularly in concrete. He will probably, in his early attempts, find bricklaying slow work and stonework still slower; but if he will not begrudge this one factor of time, the knack of such work will be acquired with some practice.

CONCRETE AND CEMENT

For the sake of a clearer understanding of concrete work and cement work, it may be well to start with a few definitions.

Cement. Although the early Egyptians knew enough about cement to accomplish some remarkable construction, and though the Aztecs and Romans were thoroughly proficient in its use, the art was lost in the Middle Ages. Strangely

enough, even those marvelous architectural flowerings, the cathedrals of Europe, were sadly deficient in this important structural feature. Their builders utilized lime mortars of rather short life and comparatively poor binding properties. Consequently, repairs are almost constantly being made in the masonry.

It was not until 1756 that the necessity for replacing the famous Eddystone Lighthouse gave an opportunity to an English engineer, John Smeaton (1724–1792), to discover the cementing properties in clayey limestones when burned and pulverized, and the much-needed property of setting under water. Necessity once again became the mother of invention when, in 1818, Canvass White (1790–1834) produced cement from a natural rock in New York State for the building of the Erie Canal. From that time until about 1900 the production of natural cements grew by leaps and bounds.

Meanwhile, in 1825, an English brickmaker, Joseph Aspdin of Leeds, invented Portland cement and took out a patent on its manufacture. Its name came from a fancied resemblance to the famous limestone of the Isle of Portland in Dorsetshire. In fact, the patent covered the making of "artificial stone." The natural cements were made by burning and pulverizing a natural rock, but this superior cement of Aspdin's was made by burning a pulverized arbitrary mixture of lime-

stone and clay. Aspdin went nature one better by controlling the contents of the mixture that went into the kilns, and produced the first crude batches of a cement that, as compared to natural cement, sets more slowly, permits the use of much more sand, and has a greater ultimate strength.

Portland cement was hardly produced commercially until twenty years after its invention, and was not produced in the United States until 1872, by David O. Saylor (1827–1884) of Coplay, Pennsylvania, with whom were associated Adam Woolever (1833–1882), Esaias Rehrig (1831–1881), and Willoughby Focht (1835–1916). Its superiority over the natural cements became more widely known during the latter part of the nineteenth century, and at the end it had definitely displaced them in popular favor. The revolution brought about by the use of Portland cement in all masonry construction is one of the great milestones in the progress of civilization.

Portland cement is now sold by the bag or barrel. A bag contains ninety-four pounds, and there are four of these to the barrel.

Cement Paste is a mixture of cement and water.

Cement Mortar is a mixture of cement, sand, and water.

Concrete is a mixture of cement, sand, and a coarse aggregate consisting generally of either gravel, broken stone, or cinders. With cinders as aggregate, the concrete is called cinder concrete

and is used chiefly for a fill where no great strength is needed.

The Principle of Concrete. If we were to pack marbles in a box in the most compact manner possible, the air spaces inclosed would be about twenty-six per cent. of the whole. If cannon balls were used instead, the proportion of voids would be the same. If we should take our box of cannon balls, however, and shake the marbles into it, these would help fill the larger voids without adding to the bulk. If shot were then sifted in, these, too, would find plenty of room between the larger spheres. With a nice proportioning of relative sizes, so that each successively smaller sphere just filled a void between the next larger spheres, we should bring our percentage of voids down to the minimum.

This is the essential principle of concrete. The cannon balls represent the aggregate — broken stone or gravel; the marbles represent the sand; the shot represents the particles of cement. The analogy fails here, however, for the cement particles, when wet, may be considered as particles no longer, but rather as a paste that surrounds each grain of sand and cements it to its neighbors and to the larger pieces of aggregate, turning the whole into a pudding-like mass that in forty-five minutes attains its initial set.

It is important, therefore, that no more cement paste, mortar, or concrete be mixed at one time

than can be put into place within forty-five minutes after the water is added.

Another helpful way of considering concrete is not as a mixture of stone, sand, and cement, but rather as a collection of stones embedded in a minimum amount of mortar.

The Choice of Sand. Sand that is to be used in cement mortar should be screened free from pebbles. In mixing the small quantities that would be used about the home, it may be found convenient to pass it through an old window screen, though a coarser mesh — ten wires to the inch — would serve the purpose better and with less waste. Sea sand is not fit for use in cement work on account of the salts present, which will appear as efflorescence upon the finished work. Loam in the sand has a weakening effect and may easily be detected by squeezing a handful of the dry sand in the hand. If, when the fingers are opened, the sand does not fall readily apart, it contains too much loam to be acceptable.

Though there is a general impression that, on account of its rough faces, broken stone makes stronger concrete than gravel, engineering tests seem to indicate that the smooth-surfaced aggregate, when fully embedded in mortar, makes a concrete that is just as strong. Other tests point to an advantage in the use of a mixture of broken stone and gravel as the coarse aggregate. There is no doubt whatever that, whichever form

is used, a variation in size is better than the screening of material to a single size, on account of the better filling of voids in the former case.

Four Mixtures. The proportions of cement, sand, and coarse aggregate vary with the purpose for which the concrete is used. Taylor and Thompson's authoritative work, "A Treatise on Concrete, Plain and Reinforced" (1905; third edition, 1916), gives the following:

A Rich Mixture — for columns and other structural parts subject to high stresses or requiring exceptional water-tightness: Proportions, 1 : 1½ : 3. That is,

1 barrel (4 bags) packed Portland cement
1½ barrels (5.7 cubic feet) loose sand
3 barrels (11.4 cubic feet) loose gravel or broken stone

A Standard Mixture — for reënforced floors, beams, and columns; for arches; for reënforced engine or machine foundations subject to vibrations; for tanks, sewers, conduits, and other water-tight work: Proportions, 1 : 2 : 4. That is,

1 barrel packed Portland cement
2 barrels loose sand
4 barrels loose gravel or broken stone

A Medium Mixture — for ordinary machine foundations, retaining walls, abutments, piers, thin foundation walls, building walls, ordinary floors, sidewalks, and sewers with heavy walls: Proportions, 1 : 2½ : 5. That is,

1 barrel packed Portland cement
2½ barrels loose sand
5 barrels loose gravel or broken stone

A Lean Mixture — for unimportant work in masses; for heavy walls; for large foundations supporting a stationary load; and for backing for stone masonry. Proportions, 1 : 3 : 6. That is,

1 barrel packed Portland cement
3 barrels loose sand
6 barrels loose gravel or broken stone

The Mixing Process. For mixing concrete in the small quantities used about the home, a water-tight box will be needed. Although the usual recommendation is a rather shallow box of four or five feet square, I have found it more convenient to use a box about five feet long, a foot wide, and about a foot deep. In one end of it is placed the sand, and upon this the cement. The two are turned over and over with spade or hoe until the mixture shows a uniform color. Then the water is added, a little at a time, for it is only too easy to pass from the "not enough" stage to the "too much." With the mixing of a batch or two, the amount of water needed will have been noted and then may be added in bulk. The mortar is thoroughly turned over and over with the spade, and the high sides of the box suggested will facilitate this operation. The consistency wanted is that of a paste that will sink of

its own weight when piled, yet will be just stiff enough to stay on the trowel.

It is perhaps unnecessary to say that the water used must be clean. The presence of certain alkalies, and probably of most acids, would render the water unfit for concrete mixing; but these are seldom encountered.

If the mixture is not to be used as mortar, but is a step towards concrete, the coarse aggregate is next added, and the whole mass is turned over until all the stones or gravel are thoroughly coated with the mortar. It may be necessary to add a little more water to accomplish this.

Depositing the Mixture. After mixing, the concrete is immediately shoveled into the trenches or wooden forms prepared for it. Tamping with the spade itself will usually settle the concrete into place without many voids. It is well to watch the outside edges, where the material touches the forms, and see that these are well filled; the center will take care of itself. Avoid working over the concrete any more than is necessary after it is deposited, as the cement is thus brought to the surface rather than left distributed throughout the mass where it belongs.

A few trial batches will serve to determine just how much can be most conveniently mixed at one time. A comparatively small amount will mix so much more quickly and with so much less heavy lifting that two batches can be made in

less time and with less effort than can a double portion.

In building a concrete wall, it is often convenient to save concrete mixing by putting brickbats or fairly large stones in the middle of the fill as it progresses. Be particularly careful, naturally, to see that these are entirely embedded in the mixture.

When the wall is of some length, a section may be built up part way by making a sort of dam of large stones and working up to these. Then, when starting to fill the adjoining section, pull away all these stones that prove to be loose, pour over the balance of the joint a layer of cement paste of the consistency of cream, and bank the first new batch of concrete firmly against this. Wherever the work has to be stopped and continued after the first part has set, this joint of cement paste, applied over a fairly rough and well-washed face, will bind the later concrete if this be well tamped into place.

After its initial set, which may be easily broken, concrete should attain its final hard set in from three to ten hours, but its strength increases during a considerably longer time — certainly for several months, probably for more than a year.

In estimating quantities of materials needed for a given volume of concrete, it may be well to know that with the 1 : 2 : 4 (" standard ") mixture, using one bag of cement, the concrete will fill

4.5 cubic feet; with a 1:3:5 mixture, using one bag of cement, the concrete will fill 5.8 cubic feet.

Concrete work or cement work should not be attempted when there is danger from freezing. It is possible to carry it through by means of heating the elements of the mixture and by protecting the concrete against freezing during its first forty-eight hours, but the trouble and expense make that advisable in cases of necessity only. The addition of salt to the water, if efflorescence will not be objectionable, serves to lower the freezing point. Ten per cent. of salt will prevent freezing above 22 degrees Fahrenheit — one per cent. to each degree of reduction.

Forms. Little need be said about the construction of forms for concrete work or cement work, beyond the caution to have them tightly jointed and well braced against bulging. Avoid the use of dry lumber, as it will draw the moisture out of the mixture. It is hardly worth while attempting perfectly smooth-surfaced forms for concrete walls, since it is very easy to surface these as desired after the forms have been removed, and much cheaper to use rough lumber. Metal forms in portable sections may occasionally be borrowed from a contractor when the work to be done is extensive. Any form, whether of wood or of metal, should be coated with soft soap or a heavy oil, to prevent sticking.

Waterproofing. If a fountain basin of concrete

could be perfectly made, it would be as fully waterproof as a basin cut from a single hard stone. Unfortunately, however, we are not able to make concrete so good as that. It is obvious that if the concrete is made quite wet and carefully poured, it will, when set, more nearly approach a solid mass, free of voids; and this precaution will make it as nearly waterproof as it can be made without additional labor, materials, and expense. Concrete thus made and poured, if coated with cement paste before the mass has fully set, should be practically waterproof against a low head of water.

Another method includes the use of a water-repellent substance in the water employed for mixing, this substance being available under various trade names, sometimes in liquid form, sometimes as a powder or a paste.

When concrete will have to withstand a considerable head of water, a dependable but rather expensive method of waterproofing is to coat the pressure side of the wall, when dry and hard, with a membrane of tar or asphalt, applied hot with brushes. Afterwards, if appearances require it, this membrane can be covered with a coating of cement mortar.

Still another scheme, when mere damp-proofing rather than resistance to water pressure is needed, is to mix not over ten per cent. of heavy crude oil, as compared with the weight of the cement used,

with the cement mortar before the coarse aggregate is added. Five per cent. of oil is usually enough — two and a half quarts to the bag of cement. The aggregate should be moistened before it is added, and the mixing should be carried on for double the customary time. Or a cement-paste coating, containing about a pint of oil to the ten-quart bucket of cement, will give a very smooth, water-resisting finish to a floor or cistern. The concrete upon which this is to be applied must first be thoroughly washed and then coated while still damp.

In the case of a foundation wall that shows dampness on the inside, a coating of the water-repellent mixture, either brushed on as freely as it will be absorbed, or put on in a cement paste, will sometimes keep the wall dry, though such a coating has not sufficient strength to withstand any real hydraulic pressure. Naturally, the coating will be much more effective on the outside of the wall, if it can be so applied.

Concrete Blocks and Cement Bricks. In the construction of walls, piers, etc., the cost of lumber for forms may be saved by the use of concrete blocks or cement bricks. The concrete blocks are usually obtainable with a plain surface, now that the novelty of blocks imitating quarry-faced stone has passed into the limbo of outworn horrors. The cement brick at times, particularly if they happen to be manufactured near the

locality where they are used, are cheaper than clay brick. Either of these units makes possible a neat and substantial wall that can be quickly laid up with the required breaks and openings, and that may have, if this is desired, an outside facing of stucco or cement, to which may be given a choice of various textures and colors.

These blocks and bricks must necessarily be made of a very dry mixture, so that the forms may be immediately released for repeated use. The result is a far more porous product than mass concrete. Keeping the blocks well soaked with water for some time after the molds are removed, makes a better product, but this is likely to be skimped in the struggle for cheap production. It is well, therefore, before buying blocks from an unknown maker, to watch their manufacture.

These blocks or bricks must be thoroughly soaked before they are laid; otherwise they will suck the water out of the mortar and make impossible a tight bonding at the joints.

Concrete Floors. As a preliminary to the laying of a concrete floor on the ground (as, for example, for a cellar or garage), a foundation of cinders or gravel, not less than four inches thick, should be laid wet and tamped in place. On this is laid a two-layer floor of concrete, varying in thickness with the extent and needs of the floor. For a minor structure, such as a poultry house, three inches will serve. Stable stalls or a garage

should have six inches. For the cellar of a house, four inches will serve, excepting under columns and where coal or wood will be dumped. The columns will have a footing suited to the weight they bear, and the floors on which coal and wood are to be stored should be six inches thick.

A $1:2\frac{1}{2}:5$ mixture is usually used for the first or main layer, and upon this, before it has set hard, a finishing coat of $1:2$ cement mortar is spread, one inch thick, and brought to a smooth surface with a float. Unless the floor is small enough so that both courses may be laid before the lower one has set, the area to be covered should be divided up into sections of about 6×6 feet. Forms made of 2×4's or 2×6's are laid out for at least one row of sections, and then only the alternate sections are filled and finished. After these have set hard, so that the forms can be removed, the remaining sections are filled in. If the floor measures more than 25 feet in either dimension, an expansion joint should divide it. This is made by inserting a well-greased $\frac{7}{8}$-inch board in the forms, removing it after the floor has set, and filling the joint with asphalt.

The use of a top finish mixed with oil, as suggested for damp-proofing, gives a floor that is smooth and quick-drying when washed, since it absorbs no water.

Sidewalks. A four-inch floor similar to that described for the cellar is the usual construction

for cement sidewalks, thickening to six inches where crossed by a driveway. Two-by-fours on edge serve as the side pieces of the form, held in place by stakes driven just below the top surfaces. Three-feet intervals for these stakes will be none too small, to prevent bulging. The side pieces of the form must be accurately aligned and

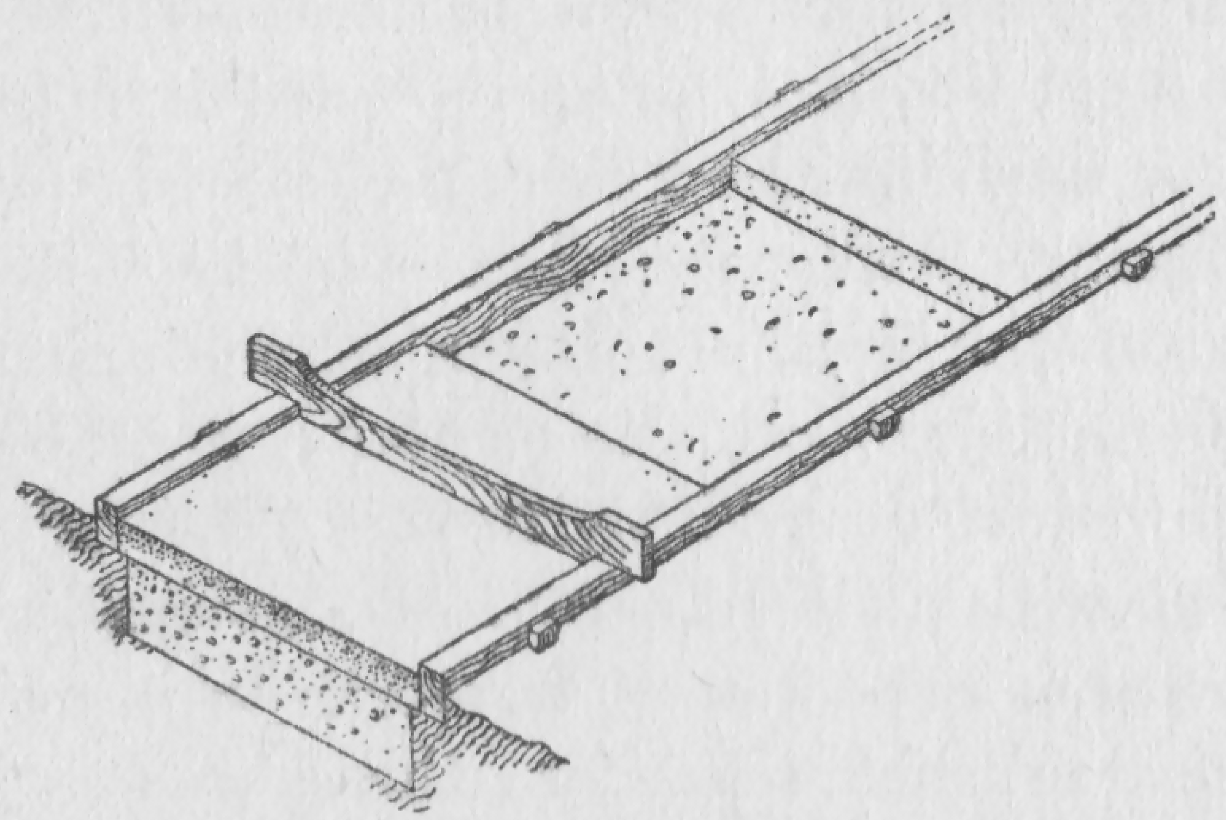

Fig. 43: The construction of a cement sidewalk. The concrete is laid on a foundation of cinders. Alternate sections are filled first. The dividing boards between the sections are removed, as here shown, after the first sections to be laid have set. Then the other sections are filled in. The striking board slides along the 2×4 inch side members of the form, to level the concrete for the top surfacing of cement. The crown line on the upper side of this board is much exaggerated in the drawing.

neatly butt-jointed to prevent an uneven edge in the finished walk. If the walk is not over four feet wide, it is easily drained by making one side a quarter of an inch lower than the other. Wider walks may be slightly crowned to shed the water to both sides. One sixteenth of an inch to the foot is ample.

When the lower layer of concrete has been put in place (the alternate-section scheme being used

if the sidewalk is long enough to require it), it is leveled by means of the striking board as shown in the diagram (Figure 43). When the board is carried along, on top of the side strips, it should be held at an acute angle rather than at right angles to the walk, to facilitate the cutting action. One edge of the striking board is cut so as to bring the surface an inch below the forms; the other side is kept straight, or is crowned if necessary, for use in striking the finishing coat of cement.

Surfacing. Following immediately after the board, on the finishing layer, should come the hand float, to smooth the cement; and this may be followed, if desired, by further smoothing and polishing with a steel trowel. Occasionally, when hard wear is expected, it is worth while to use a very hard crushed stone or other abrasive in the top coat in place of all or half the sand.

With sidewalks particularly, on account of their exposure to air and sunlight when setting, some means should be taken to prevent premature drying. Careful moistening with a fine spray after the initial set, and shading from the sun's rays, will help. This precaution applies to all concrete or cement work that is exposed to outdoor breezes and sunlight while setting. Sometimes it is easier to hang wet burlap over a wall that is so exposed.

There is a wide field for interesting experiment in the surface treatment of concrete walls. One

may wire-brush the cement and sand from the surface after the removal of the forms, but before a hard set has occurred, revealing the aggregate chosen especially for color and form. Or the outside surface may receive a thin coating of a special mixture that may be so treated. The inclusion of mica schist, crushed marble, or pebbles in various colors, as well as the washing away of the surface cement to reveal these, offers plentiful opportunity for the mason craftsman.

BRICKWORK

The home craftsman's efforts in bricklaying will probably not go beyond the laying of a fireplace hearth, the paving of a garden walk or a terrace, or the construction of a simple retaining wall, of a brick pier, or of steps.

In such work there are no great difficulties. Guide lines should be stretched to work to, indicating both vertical and horizontal faces, and wire will be found more satisfactory for this purpose than is the usual cord. All horizontal lines are verified by a mason's level or the straightedge and attached spirit level shown in the illustration in back of book. Vertical lines, if of a height too great for checking with a square, should be verified with the plumb bob.

For brick walls, piers, and the like, a foundation of concrete is usually laid from below frost line to a few inches below grade, the more expen-

sive brickwork being saved for a place where it shows.

The actual laying of brick is an operation that can hardly be learned through the written word. Watching a bricklayer at work will teach the novice more in a few minutes than he could gain by hours of reading. The baffling thing is that the skilled bricklayer, with a minimum of effort, apparently no thought, and a slapdash carelessness, accomplishes that which we amateurs will labor over, measure carefully, patch, correct, replace, and otherwise fuss with, only to produce a job that we fondly hope may be inadvertently mistaken for real bricklaying. However, it is this very difficulty of ready accomplishment that lends zest to any craft. If it were so easy that any one could do it, it would not be worth trying.

As a practical suggestion or two: Have the bricks wet before laying them. The addition of ten per cent. of hydrated lime to the cement mortar will make it much more "buttery", slower setting, and easier to work. The hydrated lime may be bought from the dealer in mason's supplies and is much better and easier to prepare than lime paste that you may slake from lump lime.

Brickwork may be cleaned, after it has set, by scrubbing it down with a weak muriatic acid solution and stiff brushes.

The accompanying diagram (Figure 44) shows a number of patterns for flat brickwork and the

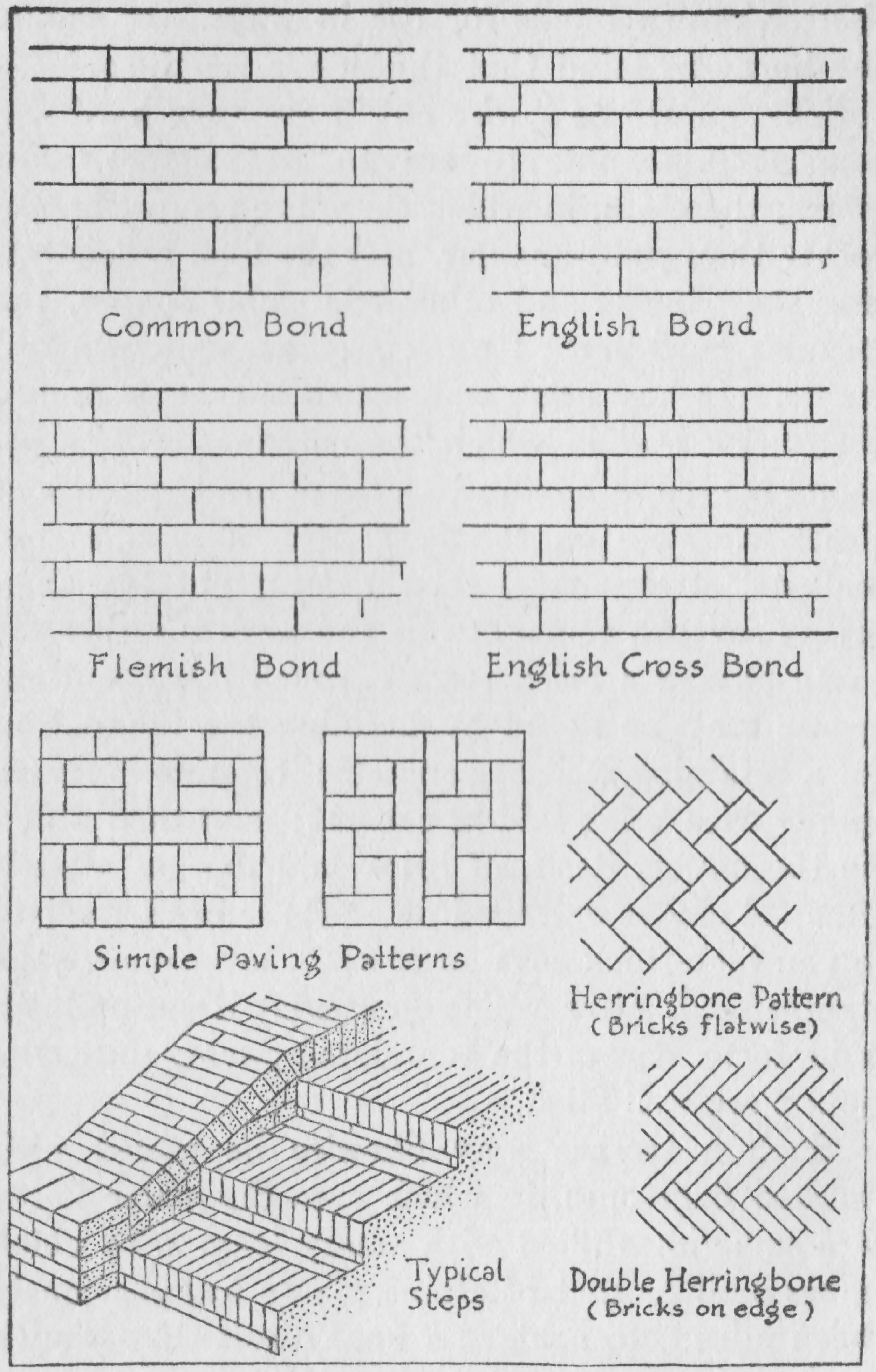

FIG. 44: Brick bonds and paving patterns.

better-known bonds for use in walls. It should be borne in mind that the newer rough-surfaced bricks, known as " wire cut ", are very hard and almost impossible to cut to odd shapes. For work, therefore, in which there are ramps, breaks other than right-angular, and the like, necessitating skew backs and other triangular shapes, the regular hard-burned brick are much more adaptable. In any brick wall which is thicker than a half-brick and in which the common or running bond is used, a bonding course of headers (ends of brick showing on the face; the long sides are called " stretchers ") should occur not less than every seventh course, to tie the work together.

In paving a brick terrace, much labor and expense may be saved by building the foundation of a retaining wall in concrete; topping it above grade with brick laid in cement; and then filling in the paving itself, of brick laid dry on a well-tamped cinder or gravel fill. These brick are laid on an inch-thick cushion of sand, leveled over the tamped fill, after which fine sand is swept back and forth across the completed paving until the joints are well filled.

Such a terrace may likewise be paved with broken flagstones, in which case the wider joints are sometimes filled with sandy loam with which grass seed or that of alpine plants has previously been mixed, to achieve a final result that is such a charming feature of many English gardens.

CHAPTER XVI

Odd Jobs

The possession of tools and a reasonable skill in their use are attributes of the home craftsman that sometimes involve a responsibility not entirely welcome. With a few hours of leisure, when he would like nothing better than to be allowed to do some wood joinery, there is likely to be a badly hung door that should be fixed, a pane of glass that really needs replacing, a bathroom shelf that has broken away from its supports; any one — or more probably six — of a hundred things may need immediate attention. He is constrained by conscience or argument to leave his favorite craft and turn journeyman odd-job man. The number of things that can go wrong in the household seems altogether out of proportion to its size.

Since they do not fall within the categories of the crafts discussed in the foregoing chapters, some of these odd jobs are here brought together for a brief explanation of methods that might not be obvious to the uninitiated.

Renewing Sash Cord. Just within the lower sash of the ordinary double-hung window, on

either side, is a vertical strip of wood about $\frac{3}{8}$-inch or $\frac{1}{2}$-inch thick by $1\frac{1}{2}$ to 2 inches wide, called a "stop." In the better class of building, this is held to the frame by screws inserted in brass pockets, permitting adjustment that will allow the sash to move without much side play. In cheaper work, the stop is nailed in place with finishing nails.

To replace a broken cord of the lower sash, this stop must first be removed from the side on which the cord is broken. Its removal will reveal, in the wood member adjoining the edge of the sash and at right angles to it, a pocket closed by a beveled piece of wood held in place by a screw. The opening of this pocket gives access to the space in which the sash weights hang. The sash may be lifted out of its runway, revealing the manner in which the cord is attached near the top. Replace the cord, making it of a length that will permit the weight almost to touch bottom when the sash is up and the maximum length of cord is behind the pulley.

It is fortunate that the upper sash, on account of its less frequent use, does not wear out its cords very often, for the outside stop must be removed to permit access to the sash edge when the cord is attached.

Shingling. Shingles are laid bottom course first, and are fastened either to a solidly boarded surface or to "shingle lath" — 1 × 2-inch strips

spaced in accordance with the amount of exposure or "weathering" the shingle courses will reveal. For side walls, shingles are nearly always put on over boarding covered with building paper and may be laid to expose a trifle less than a third of their length. For roofs, they may be laid with less exposure, according to the steepness of slope. No roof should be shingled if it has a pitch of less than thirty degrees from the horizontal. Each shingle should be held by two threepenny zinc-coated shingle nails; and these should be placed about halfway up from the butt, so that they will be covered by the next course above.

If on a roof, the bottom course, having been nailed down, is wholly covered with another course. Take care to break joints by at least an inch. It is customary to stretch a chalked line across this lower course and snap the line to mark the butt edge of the next course above. Shingles should not be laid too tightly together; else when they become wet and then swell, they will buckle. Laying them naturally as they come, without marked effort to get them snug, will usually avoid this buckling. The top course at the ridge is covered by a pair of wooden strips closely jointed together in white lead; or, on less important work, the shingles of one slope are allowed to project an inch or so above the other slope, to give some protection to the joining.

Where old shingles are to be replaced, start removing these at the bottom, and take off only the courses that can be replaced before danger of damage by wet weather.

Shingles may be purchased that have been dipped in creosote stain; or if desired, a coat or two of stain may be given to the finished surface with the brush. The former method is better in results and saves work. Shingles that are to be painted — as for a side wall — are sometimes dipped in a thin paint and laid when dry, and then a final brush coat or two may be given to them. In dipping, the paint is mixed in a tub or half-barrel, and three or four shingles, held apart by the fingers, are dipped at one time. They need not be entirely submerged, since the thin upper ends will be well covered by the upper courses. After dipping, the shingles are simply tossed upon a pile to dry.

Shingles that are dipped have about twice the life of untreated shingles. On side walls, where shingles are painted when put on, and kept painted, they last indefinitely. Many houses on Long Island, where this practice was customary with the early builders, have stood for a hundred and twenty-five years with little sign of deterioration excepting at the ground level.

Shingles are sold by the bundle, usually four bundles to the thousand. A "thousand" random-width shingles means the equivalent of one

thousand shingles four inches wide. Their covering area when laid is as follows:

Laid	$4\frac{1}{2}$	inches to weather . . .	125	square feet
"	5	" . . .	138	"
"	$5\frac{1}{2}$	" . . .	152	"
"	6	" . . .	166	"

Glazing. If the house has windows divided into small panes of a standard size (8 × 10 inches, 9 × 12, 10 × 12, 10 × 14, or 12 × 14), it is a great convenience to buy glass of the required size by the box, so that there will always be a supply on hand when needed.

If the glass has to be cut to special dimensions, this will be done, if desired, by the hardware dealer. If the glass is cut in the craftsman's own shop, it is a convenience to have a perfectly flat board, say two by three feet, the face of which is ruled both ways at quarter-inch intervals, with the inch lines heavier and indicated by number at one side. The sheet of glass is placed with two edges at the zero sides of the ruled board, a straight-edge is laid across at the required distance and the steel-wheeled glass cutter drawn firmly along its guiding edge. If the glass does not readily break at the cut, it should be held vertically in both hands, cut side towards the handler, and tapped on the front top edge of the workbench as nearly as possible in line with the cut. If the top piece is worth saving, it may be held in one

hand, as it will usually break when it topples over on the bench. When the glass is fairly thick, the back of the cut should be tapped along its whole length with the end of the cutter. This tends to carry the cut through the glass on a straight break. In the side of the cutter there are several slots of varying widths in which to engage small projections of the glass and break them off. This operation is seldom successful in my own hands; which indicates, for me at least, the desirability of making the cut itself with an even and firm pressure throughout its length.

For cleaning out the remnants of a broken pane from the muntin rebates, an old jackknife or screwdriver will serve. Such work is ruinous to the putty knife or to a chisel. The steel scraper is sometimes useful in removing the last vestiges of hard putty without the danger of cutting into the thin wood underneath.

Once cleaned, the rebate should have a coat of lead-and-oil paint, after which the glass may be inserted at once and held in place with several glazier's points. These little triangles are started with the fingers, then a few taps are given them with the side edge of a heavy chisel held so that its bevel slides over the glass. The old-time glazier considered it necessary to put a bedding of putty in the rebate first and press the glass firmly into it. Unquestionably this makes the best sort of job if done well, but the amateur will

not be likely to get the putty evenly distributed. The glass will be held away from the muntin, with unfilled gaps showing inside, and the inside edge will need painting to hide the putty. Personally, I prefer a closer junction of glass and inside woodwork, trusting to firm pressure on the putty bevel, when it is applied, to give a weather-tight job. The putty should be of such a consistency that it will take a smooth surface and not crumble when the putty knife is drawn across it to press it into place. A few drops of linseed oil will soften it; the addition of a little whiting will thicken it.

After the bevel has been completed, it should be painted. Another coat or two should be applied after a day or two.

Soldering. For a tight joint between copper and copper, copper and brass, copper and iron, brass and iron, brass and brass, tin and tin, or tin and other metals, soldering is indispensable. The surfaces to be joined must first be thoroughly cleaned and scraped to bright metal. A prepared flux, called "soldering paste", is next applied over these cleaned surfaces. Meanwhile the soldering "iron" — which is of copper held between iron prongs — is being heated, either over a blue gas flame or by means of a self-contained electric heating unit. The iron must not be red hot. It will melt solder long before reaching that point; and if it is too hot, the solder will not adhere to it.

Moreover, the copper bit must be perfectly clean — free of soot and rubbed bright with a file or emery cloth. The bit itself must receive a coating of solder, with the aid of paste, after which it is drawn across the edges that are later to be joined, a piece of solder wire being held against it to melt as the layer is laid on. Both edges having been given a coating, they are brought into contact, some paste again applied, and more solder melted over the joint. The copper bit is finally drawn across alone to smooth the joint where smoothing is needed, and to flow the solder into all the crevices.

When it is desired to leave a portion of the joint free of solder, a paste made of whiting and water will effectually prevent the solder from adhering.

A simple and convenient method of soldering small bits of flat metal together is by coating the surface with soldering paste, putting a sheet of tinfoil between them, and bringing the plates together between hot flatirons.

Paneling. It will be strange indeed if, among the many paths beckoning the craftsman to make his house a more beautiful place in which to live, he remains oblivious to the lure of paneling wall surfaces. Whether the architecture is based upon the timberwork of England, or upon the early American precedents, paneling is a vital detail that, all too frequently, has been given up in the final struggle to bring down building costs. For-

tunately, it may be added at any time, and offers no particular difficulties to the moderately skilled woodworker.

The typical section of paneling is shown in Figure 45, in which the thick wood member represents the stiles and rails. These terms designate the skeleton framework into which the panels are jointed — a stile being a vertical member and a rail one of the horizontal members. These are kept uniform in width, averaging about four inches, and the panels themselves are usually made as wide as the available wood permits and in accordance with the horizontal division of the space. The length of the panels depends upon the design. Tall, narrow shapes tend to increase the apparent height of a wall, whereas long horizontal panels make it seem lower. In addition to stiles, rails, and panels, a separate molding is often, though not necessarily, used to cover the loose joint between the panel edges and the framework.

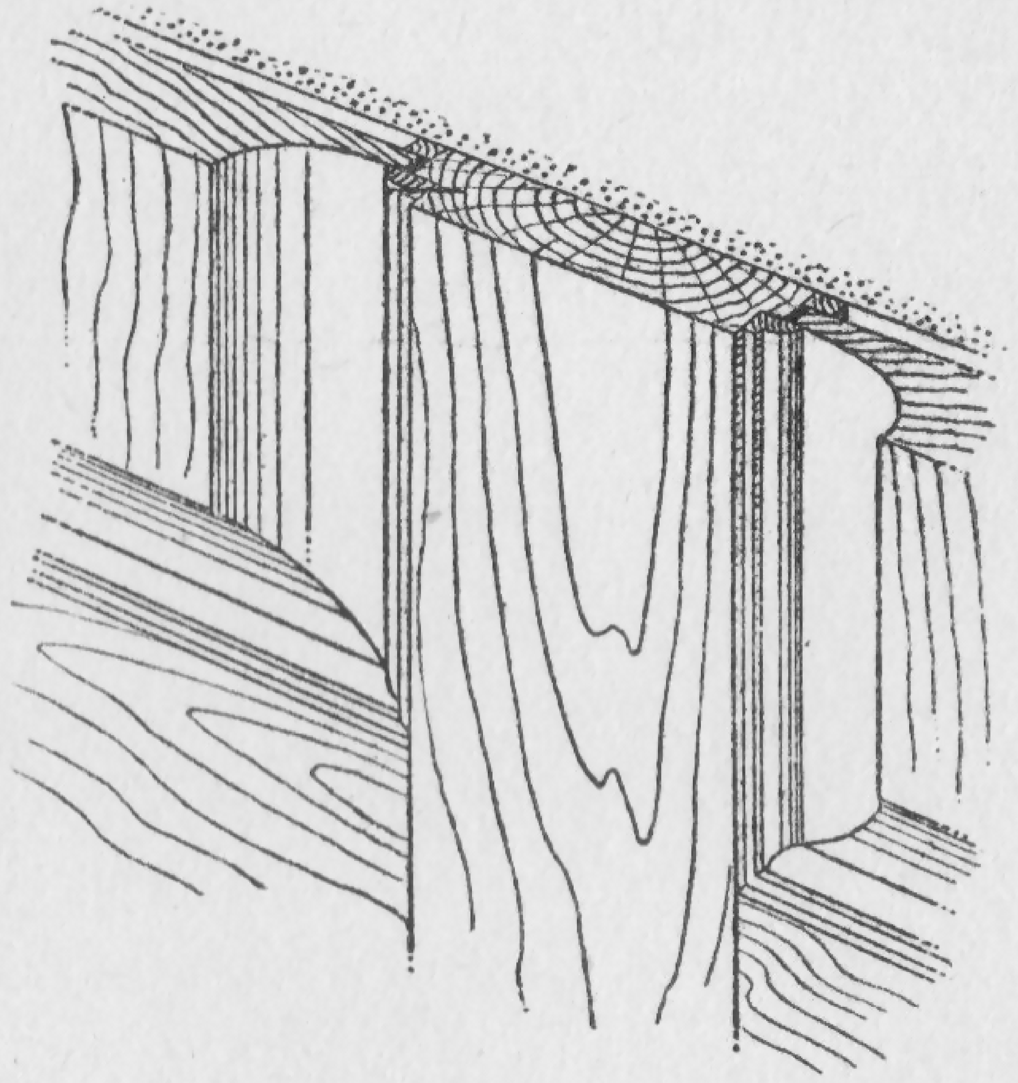

FIG. 45: A horizontal cross-section through paneling set against a plaster wall.

This joint is not glued, being left free to accommodate the contraction of the wood as it dries out. For the same reason, the cover-molding should be fastened to the stile or rail by small finishing nails, and not to the panel.

Paneling is usually put together in the shop — or, if too large, on the floor of the room itself —

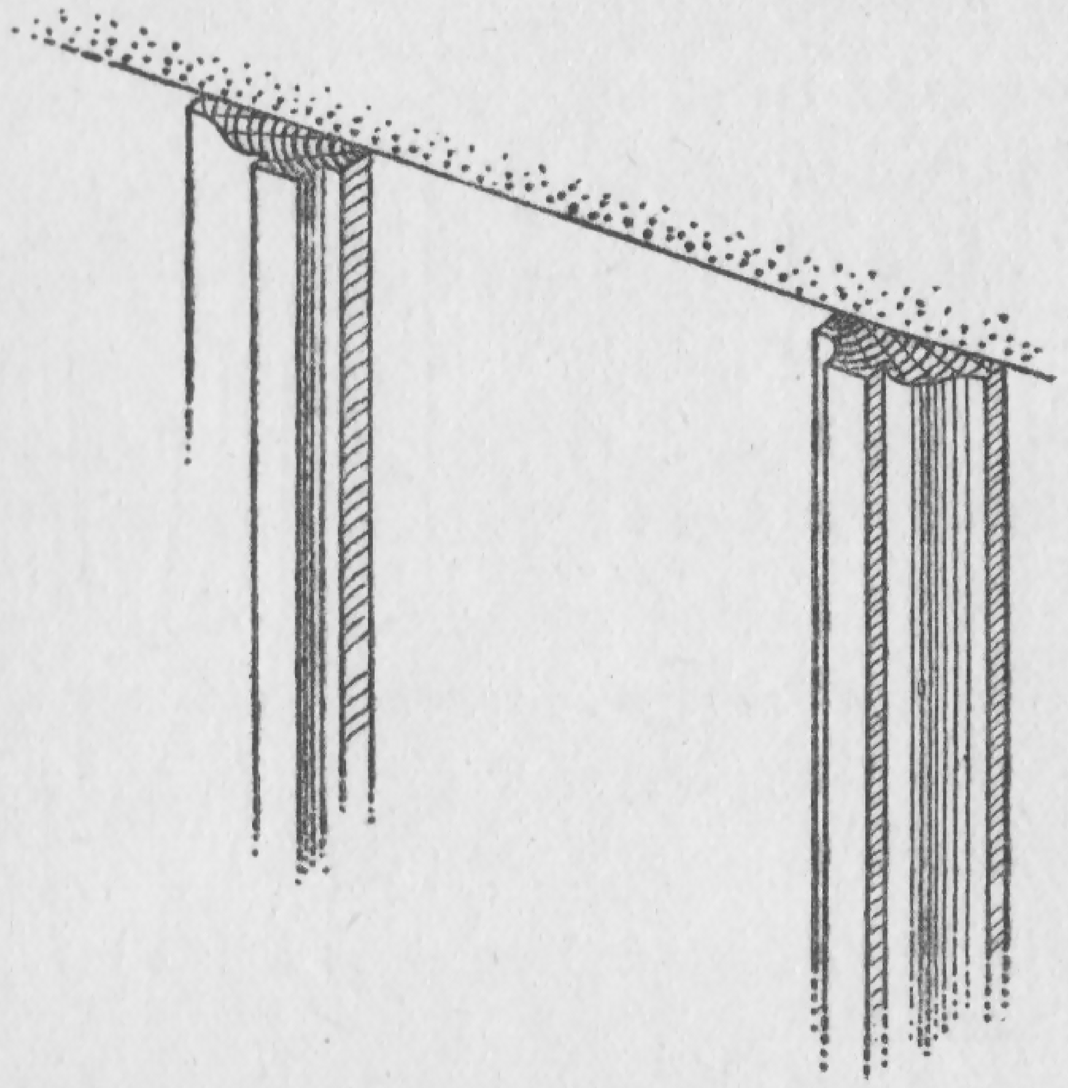

FIG. 46: An approximation to paneling is obtained by nailing wood molding strips directly on a plaster wall and then painting wood and plaster together.

and raised into place as a whole. In the design, provision is usually made for a baseboard member, overlapping the bottom rail, and also for either a cornice or a simple cover-molding for the top at its junction with wall or ceiling. A cover-molding is also needed to finish the junction with door and window trim, mantels, or other standing woodwork. The size of the framework should be so

fixed as to allow for these slightly overlapping members, leaving the standard width of rail or stile exposed.

In the design of paneling, it will save much cause for regret if some of the many excellent books on English or Colonial architecture are consulted before the working sketches are made.

Where true paneling is out of the question for reasons of size and expense, an approximation to a painted paneled wall may be had by nailing molding strips directly to the plastering, as indicated by Figure 46. Where this is done, the important and too infrequently observed principles of stile, rail, and panel should govern the design. There is nothing much more annoying to the architecturally trained eye than a varying width of rail and stile to fit local exigencies of space, without the slightest regard for adherence to the traditional paneling construction, even in appearance.

In this false paneling with molding strips, the molding should have very little projection, the corners be neatly mitered, nail holes puttied, and woodwork and plaster painted together.

Fastening to Plaster Walls. Of the most common repair jobs that fall to the lot of the home craftsman, one sort arises from the failure of screws to hold in plaster walls. Bathroom fittings are particularly annoying offenders in this respect, and in working loose they usually break out

enough plaster to make very difficult the reëstablishment of a secure support.

One method of gaining a new hold for a screw that has worked loose in this way is to whittle a soft wooden plug to fit the hole as snugly as possible, and patch around it, if the surface has been broken away, with patching plaster. After this has set, the screw may be reset in the plug, and the expansion of the plug will usually give a tight hold. The smaller the plug in diameter, the better, for with too much wood the expansion is not transmitted to the circumference. Even a few matchsticks, dipped in glue and driven in side by side until the hole is full, will often make a lasting hold for the screw.

When putting up fixtures for the first time, it is of great advantage to place the screws where they will enter a lath. When they pass between adjacent laths, they gain little if any grip on the threads. It is better to withdraw such a screw, patch the hole, and try to engage a lath by a slight change in location.

Refinishing Old Furniture. In these days, when there still remain for the persevering collector a few pieces here and there, monuments to the skill and discriminating taste of early cabinetmakers, a knowledge of refinishing is an essential part of the amateur craftsman's repertoire. Upon the great mass of this old furniture, coat after coat of varnish has been added through the years,

ending frequently with a coat or two of paint. All of this must first be removed. One of the prepared varnish removers will soften a layer or two at a time, so that the coating can be scraped off with the cabinet scraper and finally wiped down to the wood with a cloth well moistened with the same fluid. In the crevices of moldings, flutings, and carving, a sharp stick will be of service, covered with the cloth and dipped repeatedly into the remover. Or a small stiff-bristled hand brush may be used. After the remover has done its work, the surface should be cleaned thoroughly with benzine.

Bad breaks can be patched by setting in new pieces of the same kind of wood, selected to match the grain as nearly as may be. Missing veneer can be replaced as explained elsewhere in this chapter. Surface holes that are too small to plug may be touched inside with hot glue, then filled with a dough of sawdust from the same kind of wood, mixed with hot glue. Slight depressions in a table top or conspicuous panel may often be brought up by moistening repeatedly the wood about the dent, covering it with a sheet of heavy paper, and resting upon the paper a rather warm flatiron. Stains that do not disappear with scraping can be planed out, and the surface smoothed by a well-sharpened scraper and Number 0 sandpaper.

Staining the repaired spots to match the color

of the main surfaces is accomplished with the wood dyes, well thinned and applied with a small brush, so as to build up to the desired color with successive applications rather than risk getting too dark a shade. Allow the stain to dry for at least twelve hours, and sandpaper the surface lightly with Number 00 to remove the ends of the grain that have been raised by the stain.

In open-grained woods, a paste filler will be needed, applied as explained for new work (see page 125), since the varnish remover will have lifted some of that which was put in with the original finish. After the filler has dried for at least two days, one of several surface finishes may be given to the woodwork — either a shellac-and-wax finish, a varnished finish, or French polish.

For the shellac-and-wax finish, the surface receives as many as five or six thin coats of the best white shellac. Rub each coat down after it is dry: the first two with Number 00 sandpaper, the others with pumice stone and oil, rubbing mainly across the grain. The waxing is done by building up a pad on the bottom of a block of wood, covering the whole with a piece of lintless cloth, and rubbing the wax upon the shellacked surface, with and across the grain, with enough pressure and friction to melt the wax into a thin, unbroken coating. After this has dried for a day or two, polish it with a heavy block wrapped in cloth. The addition of another

coat or two will improve the finish. This finish is quite durable and, of course, may easily be renewed by rewaxing.

The varnish finish, either rubbed or with a final coat of flat-finishing varnish, has been described on page 126.

French polishing has long been a great favorite of furniture collectors and skilled refinishers because its thin, brilliant, transparent coating shows to full advantage all the beauty of the wood beneath. It is a method requiring more labor than any of the others, together with a skill that comes only with experience and long practice. Parenthetically, it may be said that French polish dates only from the period about 1750–1800, when inlay and veneer were freely employed by the great Georgian cabinetmakers. Before that, for oak, walnut, and mahogany, the wax finish was the one chiefly used.

Upon the stained and filled surface apply a thin coat of shellac. Orange shellac will do for a dark wood; but if the wood is maple or light birch, use the clearest shellac obtainable. After this has dried, the remainder of the finish is applied by rubbing a very thin coat upon the surface with a pad wrapped in a cloth entirely free from lint. The pad is dipped into a saucer of shellac, covered up with its outer wrapping, and rubbed with a circular motion lightly over the surface. The rubbing pad should be pressed down with suffi-

cient weight to force the shellac out upon the lintless wrapper and distribute it on the woodwork. A saucer of raw linseed oil should also be kept at hand and the pad merely touched to this from time to time to avoid too much tackiness. Use no more oil than necessary, for what goes in must all be rubbed out again. Rub over a small area at one edge and gradually extend it across the whole surface. Allow the work to dry for twenty-four hours, well protected from dust, and then repeat the operation. This should be done four or five times. Keep the shellac in the saucer thin by adding denatured alcohol from time to time, to replace that which evaporates. The successive coats should be of thinner and thinner shellac.

The next operation, called "spiriting off", must be very carefully done lest all the work that has gone into the rubbing be itself "spirited off." A piece of lintless cloth is wrapped about the fingers and very slightly moistened — *not wet* — with the alcohol alone. This is rubbed lightly over the surface, to smooth up any infinitesimal ridges that may have been left and to bring up the real gloss. Finally, polish vigorously with an old silk handkerchief. If a *dull* French polish is preferred, omit the "spiriting off" and rub instead with piano felt dipped in oil and powdered pumice.

Veneering is a craft in itself. The selection of the wood for the ground, providing against its

tendency to warp; the differences between veneers cut in various ways; back-filling; hot or wet gluing; and a host of other technicalities are beyond the scope of this book. For the lesser problems involved in patching veneered surfaces or replacing detached bits, no such deep knowledge is necessary.

All old glue must of course be removed; and the "ground" or surface to be covered must be left level and true, but rough rather than smooth. Scoring it diagonally both ways with a series of parallel lines made by a steel point will give the desired tooth to hold the veneer. This surface is then brushed clean and coated thinly with a glue size, so that the suction of the pores will not draw the glue coating away from the veneer itself. When the veneer is to be applied where old wood has been well filled by previous gluing, this sizing is unnecessary. End grain will take more of a coating than side grain, but in neither case should sufficient glue be used to show as a coating when dry. If it does show, the scoring of the surface should be repeated.

For small patching, the use of cauls is preferable to wetting the veneer and laying it with a veneering hammer, which is a sort of metal squeegee. The caul is a flat metal plate, heated to a point where the hand cannot comfortably touch it, and pressed upon the veneer with clamps. The cabinet scraper makes a very convenient caul of

small size, but care must be taken that it is not heated enough to draw the temper from the steel.

After the veneer has been cut to the exact size needed, with the character and direction of its grain matching its surrounding veneer, the adjoining edges are very slightly undercut to a bevel. To the ground is then given a coating of glue, and to the back of the veneer a very thin coat. Both of these must be set aside to dry until they have lost their tackiness when touched by the finger; only then are they brought into contact. A sheet of paper is placed over the patch and the heated caul is clamped firmly over this. The heat softens the glue sufficiently to give a firm hold. After the glue has had time to dry hard, the caul and paper are removed; the patch is sandpapered, to remove any surplus glue; and the surface is refinished.

Plastering seems to be the progressive member of the building family. Methods and materials do not change rapidly in heating, painting, construction, plumbing, and wiring. A few years ago, this list might have included plastering, but it does not to-day. The need for patching a broken wall or a fallen ceiling, a few years ago, would have started a long, tedious, and very mussy job. Lime would have had to be slaked in a tight box and allowed to stand for at least a week. Sand of the right sort would have been

sought, and cattle hair in lumps broken up and mixed with the lime putty and sand.

To-day this assembling of materials is done by manufacturers and the proper mixture of gypsum plaster, fiber, and sand is sold in barrels or bags. The contents, mixed with water only, make the first coat in two-coat plastering, or the first and second coats in three-coat work. The materials for the finishing coat — calcined gypsum or plaster of Paris, and hydrated lime — are also bought in barrels or bags and mixed with water for use. One part of plaster of Paris to three parts of lime putty are used, being mixed just before using. The advantage of hydrated lime for making the lime putty, by the addition of water, lies in the fact that the slow chemical process of slaking has already been thoroughly done and the excess water then evaporated.

For patching, the lath or plaster-board base should first be wet, so that it will not absorb the water from the plaster. A coat of the sand plaster should be put on and pressed into a good clinch with the plasterer's trowel, the surface being kept a quarter of an inch or so below that of the neighboring plaster. After the sand plaster has thoroughly set and is almost dry, the finishing coat of plaster of Paris and lime putty is applied and troweled smooth and hard to the plane of the finished wall. A whitewash brush dipped in clean water will aid in keeping the new surface

workable until this hard, smooth surface is achieved.

Plastering Substitutes. Not only has plastering itself been made easier to do, but many substitutes have come upon the market. Sheets of wood pulp, of various fibers, and even of gypsum plaster, are sold ready to be nailed upon a carefully trued framing. Some of the pulp products are prone to bulging out of true, due to their absorption of dampness. Back-painting of these sheets, in addition to the decorative painting of the front surfaces, should obviate this trouble, though most people apparently prefer to take a chance and paint only the front. The wood-fiber sheets, put together in several layers (like three-ply panel boards), seem less liable to buckling; and of course the gypsum-plaster sheets, very much heavier and nonabsorbent, are entirely proof against it.

The sheets come in standard widths, usually figured to give butt joints and nailings on 2 × 4-inch studding, 16 inches on centers. Wood strips or moldings may be used to cover these joints and effect a paneled scheme; or special plasters are made to fill the joints and nail holes and make the whole area smooth for painting or papering.

One of the latest developments of this age of plaster improvement is a sort of combination plaster and paint, sold in powder form. Mixed

with water, it is put on with a brush, either over a fairly smooth coat of sand plaster or over an old plaster wall. Before it has set, any one of a wide variety of textures may be given to it. Put on thickly, it may take the rough, swirling finish given with a plasterer's trowel or wooden darby. Or the brush marks themselves may be kept rough and irregular enough to give an interesting texture. Stippling is possible, with a stiff brush; or the use of a crumpled piece of cloth or paper, or of a sponge, will give varied surface textures in skilled hands. After drying overnight, the wall may be sized and painted, or "antiqued" by applying a coat of paint and wiping it off before it has dried. It is possible also to mix a dry-color pigment with the plaster powder itself, thus avoiding the necessity for sizing and painting.

GLOSSARY

Aggregate. The materials mixed with cement and water to make concrete. Sand is the "fine" aggregate; stone, gravel, cinders, etc., form the "coarse" aggregate.

Ammeter. An instrument for measuring in amperes the amount of current passing through it. *See* Ampere.

Ampere. The practical unit of electric-current strength: such a current as would be given with one volt through a wire having a resistance of one ohm. *See* Ohm; Volt.

Armature. A piece of soft iron joining the poles of a magnet.

Armored Cable. A flexible metal covering for electric wires, made of two interlocking strips, spirally wound.

Baseboard Socket. An outlet connection in a wiring circuit, located in the baseboard along the lower edge of an inside wall or partition. From it the current is led through a plug connection and a flexible cord to a portable fixture.

Batten. A strip of wood fastened across the back surface of two boards to hold them together in the same plane.

BENCH STOP. A plug of wood or metal that may be drawn up above the surface of the workbench to hold work that is being planed.

BEVEL. An instrument somewhat like a TRY-SQUARE (*q.v.*), but with a pivoted blade held by a set screw in the stock; used as a guide for making lines at angles other than right angles to the guiding edge.

BIBB. A bibcock or faucet.

BIT. A tool for boring, having a shank for fitting it to a BRACE (*q.v.*).

BIT STOP. A device fastened to an auger bit to prevent its entering the wood beyond a desired depth.

BRACE. A tool having a crank motion for holding and rotating drilling tools or bits, such as auger bits. *See* BIT.

BRACE RULE. A table marked on the STEEL SQUARE (*q.v.*), giving lengths of diagonals for right-angled triangles of various heights and bases.

BRAD. A small, slender nail, usually a wire nail.

BUSHING. In electricians' terminology, a collar or short tube of nonconducting material to protect the wires where they pass from a rigid conduit into the junction box or outlet box.

BUTT JOINT. A junction of two members that provides contact along their edges without overlapping or interlocking. It is usually a glued joint, reenforced by battens or doweling. *See* BATTEN; DOWEL.

CANOPY. The spun-brass cup-shaped fitting that encircles the main shaft of a lighting fixture and covers the hole in the wall from which the wiring emerges.

CHAMFER. To cut away at a bevel the exterior angle formed by two adjoining surfaces.

CHUCK. A device for holding an object so that it can be rotated, as on the mandrel of a lathe, or for fixing it in a drill press or other boring tool.

DARBY. *See* FLOAT, MASONS'.

DIVIDERS. A pair of pointed legs jointed to move on a pivot, for use as a compass to inscribe circles, or for stepping off a line in equal divisions.

DOVETAIL. A joint between two wood members that resists separation in all directions but one, due to the interlocking of trapezoidal tenons.

DOWEL. A pin or peg of wood, usually cylindrical, used for joining together two adjacent boards, as between the leaves of a dining table. The dowels are sometimes glued into one member, sometimes into both.

FILLER. A compound of finely powdered mineral substances, such as silex or silicon dioxide, ground in a special type of varnish and used to fill the cavities of open-grain wood before varnishing.

FILLET. A small band or molding, usually rectangular, narrow, and flat, used to separate or ornament larger moldings or members.

FINISHING NAIL. A wire nail with a very small head, which may be driven in below the surface with a nail set and concealed with putty and paint.

FLOAT, MASONS'. A smooth board fitted with a handle on its back, with which a plaster surface is brought to a plane; also called a "darby."

FORSTNER BIT. An auger bit that bores a flat-bottomed hole. It has a cup-shaped end, sharpened

along the rim, instead of the common helix. *See* BIT.

FRICTION TAPE. The common plastic tape used by electricians for wrapping a bare wire to insulate it.

GASKET. A sort of washer of soft metal or composition, used to make a tight joint in compression between two metallic surfaces.

GROUND JOINT. A joint between metallic surfaces, in which grinding and sometimes a tapered form are utilized to secure tightness.

HYDRATED LIME. Lime that has been thoroughly slaked and then dried to powder form. The addition of water makes a lime putty, ready for use.

JOINERY. The art of framing or securing together wood members to make a neat and durable joint.

JUNCTION BOX. An iron box into which electric wiring is led for the purpose of splicing or taking off a branch. It must have a removable lid, so that the wire connections inside are always accessible.

KERF. *See* SAW KERF.

LAP JOINT or LAPPED JOINT. A joint between two wood members, in which one laps either wholly or in part over the other.

LEAD. The main pigment base of exterior paints: basic lead carbonate.

LIME PUTTY. *See* HYDRATED LIME.

LITHOPONE. An important base for interior paints, made of zinc sulphate and sulphate of baryta.

MAGNETO TESTING BELL. An apparatus for generating electricity or for testing circuits. It consists of a coil rotated by a hand lever between the poles of a permanent magnet. The completed circuit is indicated by the ringing of a bell mounted as part of the apparatus.

MARKING GAUGE. An instrument for marking a line parallel to an edge and at a given distance from it. It consists of a straight bar passing through a block at right angles and secured in the block with a set screw. The bar carries a scribing point near one end. *See* SCRIBING.

MITER. The joining of two wood members at an equally divided angle, as at the corner of a picture frame.

MITER BOX. A trough-like arrangement of wood or steel, with slots through the uprights, to guide a saw at angles of 45 degrees, 90 degrees, or others in cutting moldings, etc. *See* MITER.

MOLDING. Wood that has been cut to curved or broken surfaces, occasionally carved, for decorative effect.

MUNTIN. The thin bar of wood, usually molded, that separates a pane of glass from an adjoining one in a divided window sash.

OHM. The unit of electrical resistance; concretely represented by the resistance of four hundred feet of common iron telegraph wire. *See* AMPERE; VOLT.

PACKING. A fibrous material, such as coarse yarn, used to help effect a water-tight joint between metallic surfaces.

PRIMING. The first coat of paint, in immediate contact with the surface to be covered.

Protractor. An instrument for laying off angles upon a plane surface.

Reaming. The cutting of the burred inside edge of a pipe end.

Rebate. (Usually called "rabbet.") A ledge cut along the edge of a board. In a "rabbeted" joint, two such ledges lap closely to make a tighter fit than the ordinary butt joint.

Rigid Conduit. A protective covering for electric wiring, in the form of iron pipe with comparatively thin walls.

Saw Kerf. The slot or cut made by a saw.

Scribing. An incising made with a sharp steel point, to serve as a guide line for cutting.

Slip. A whetstone of special shape for honing curved or angular blades.

Soldering Paste. A prepared flux that takes the place of the resin or chloride of zinc solution formerly used in soldering.

Spirit Level. A cylindrical tube filled almost full of a liquid and containing an air bubble that indicates by its location under a center line the exact horizontal position of the tube and its mounting — usually a bar of wood or steel.

Steel Square. An instrument with which to lay off right angles; usually marked on both arms — the "tongue" and the "blade" — with divisions of an inch and with other useful scales.

Stillson Wrench. A wrench similar to the monkey wrench, but with one jaw capable of slight angular movement to secure a grip upon pipe or similar cylindrical surfaces.

Stucco. A cement plaster used on the exterior walls of a building.

Stud. An upright timber of a frame wall. Studs usually measure 2×4 inches or 3×4 inches, and are spaced 16 inches on centers.

Tang. The tapered end of a shank on a tool, such as chisel or file, for inserting in a wooden handle.

Tap. A tool for cutting internal screw threads, as in a nut; used with a tap wrench.

Transformer. A device for producing by an alternating electric current a current of different strength, through an induction coil.

Try-square. A small right-angled testing and measuring instrument, consisting of a stock of wood or steel and a blade of steel marked in divisions of an inch.

Twist Drill. A drill or bit for cutting metal, its body cut with two spiral grooves to carry out the chips; used in a lathe or a drill press, or, in small sizes, in a hand drill or brace.

Veneer. A thin layer of rare or beautifully grained wood that is glued upon a support of commoner wood for the purpose of embellishment.

Volt. The practical unit of electromotive force: such a force as would carry one ampere of current against one ohm resistance. *See* Ampere; Ohm.

Watt. The practical unit of electric power, activity, or rate of work; equivalent approximately to $\frac{1}{746}$ of a horsepower.

Whiting. A chalk used chiefly as the base of putty (when it is mixed with linseed oil) and in making calcimine paints.

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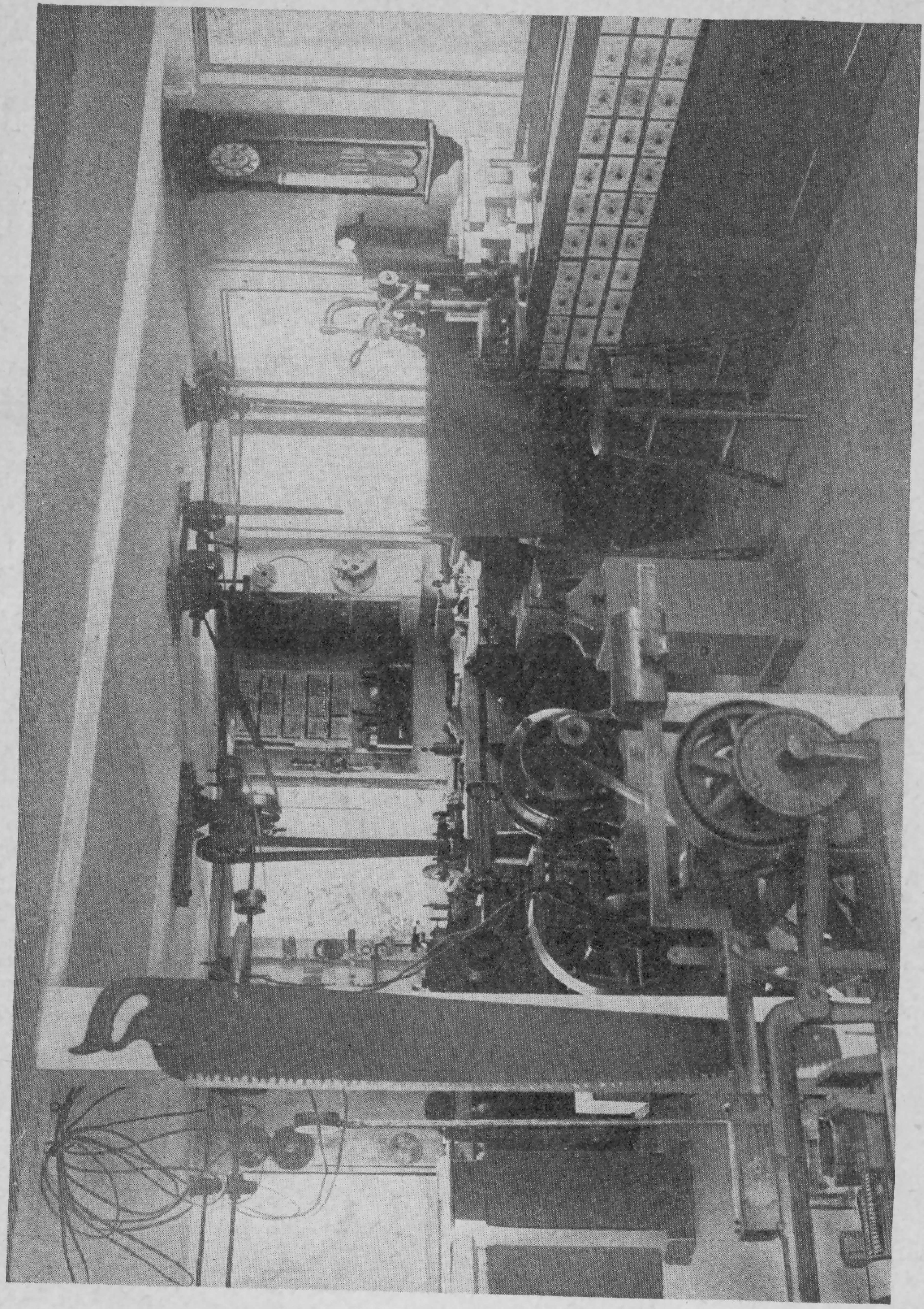
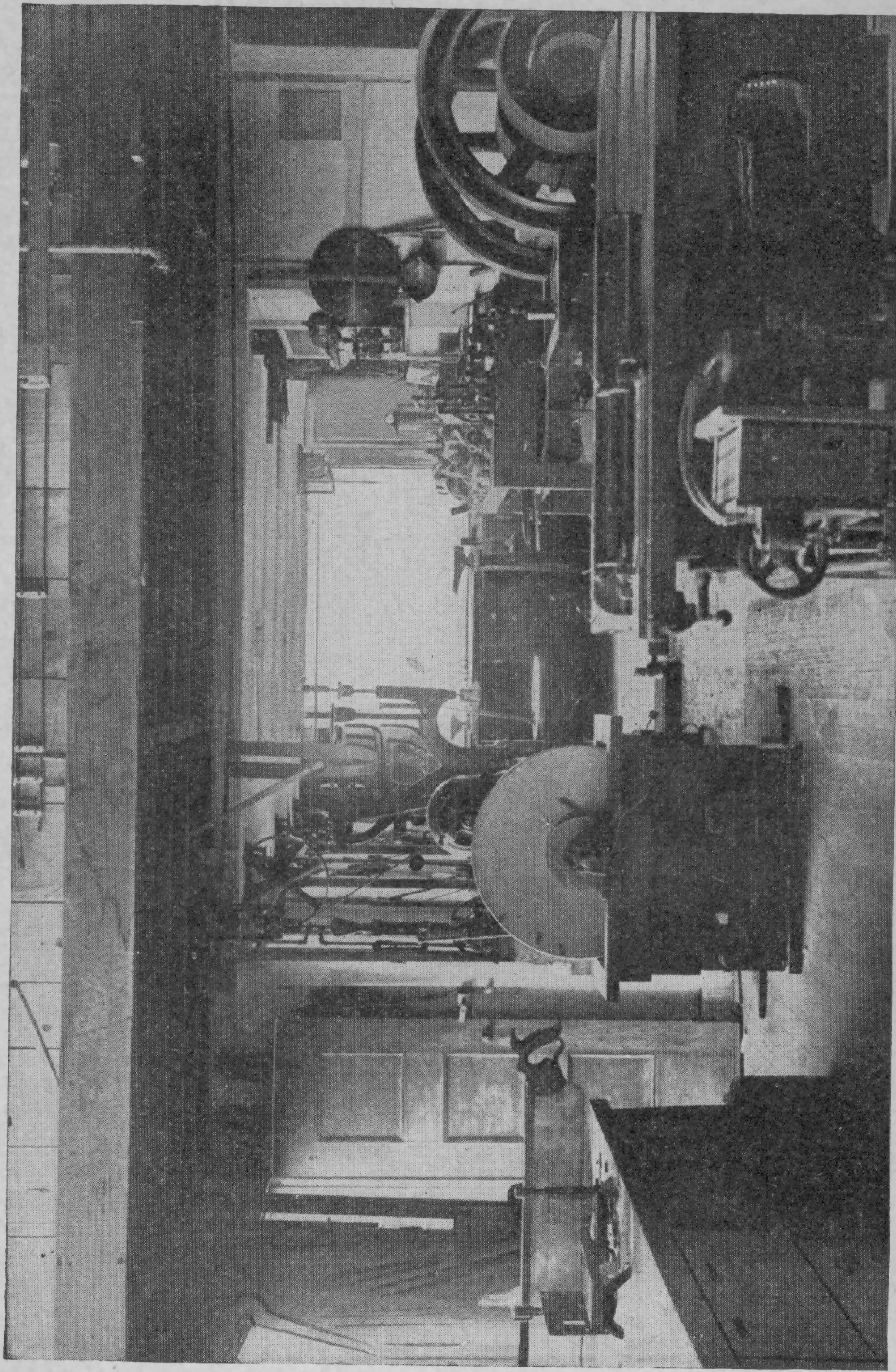


IN THE WINDSOR (VT.) WORKSHOP OF MAXFIELD PARRISH, AN ENTHUSIASTIC CRAFTSMAN

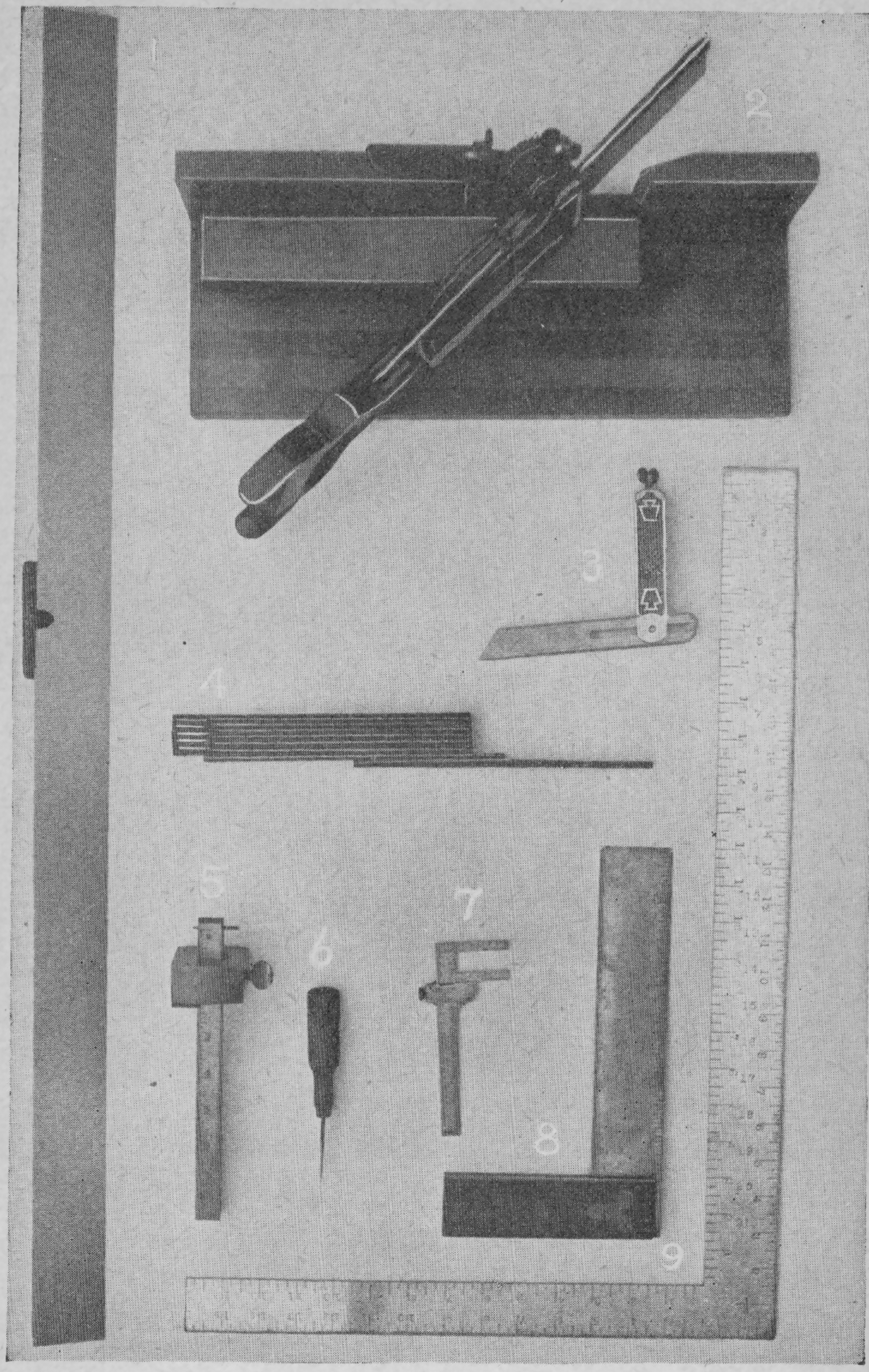


ANOTHER VIEW OF MR. PARRISH'S WORKSHOP

The equipment extends to some of the simpler planing-mill machinery, run by electric motor.

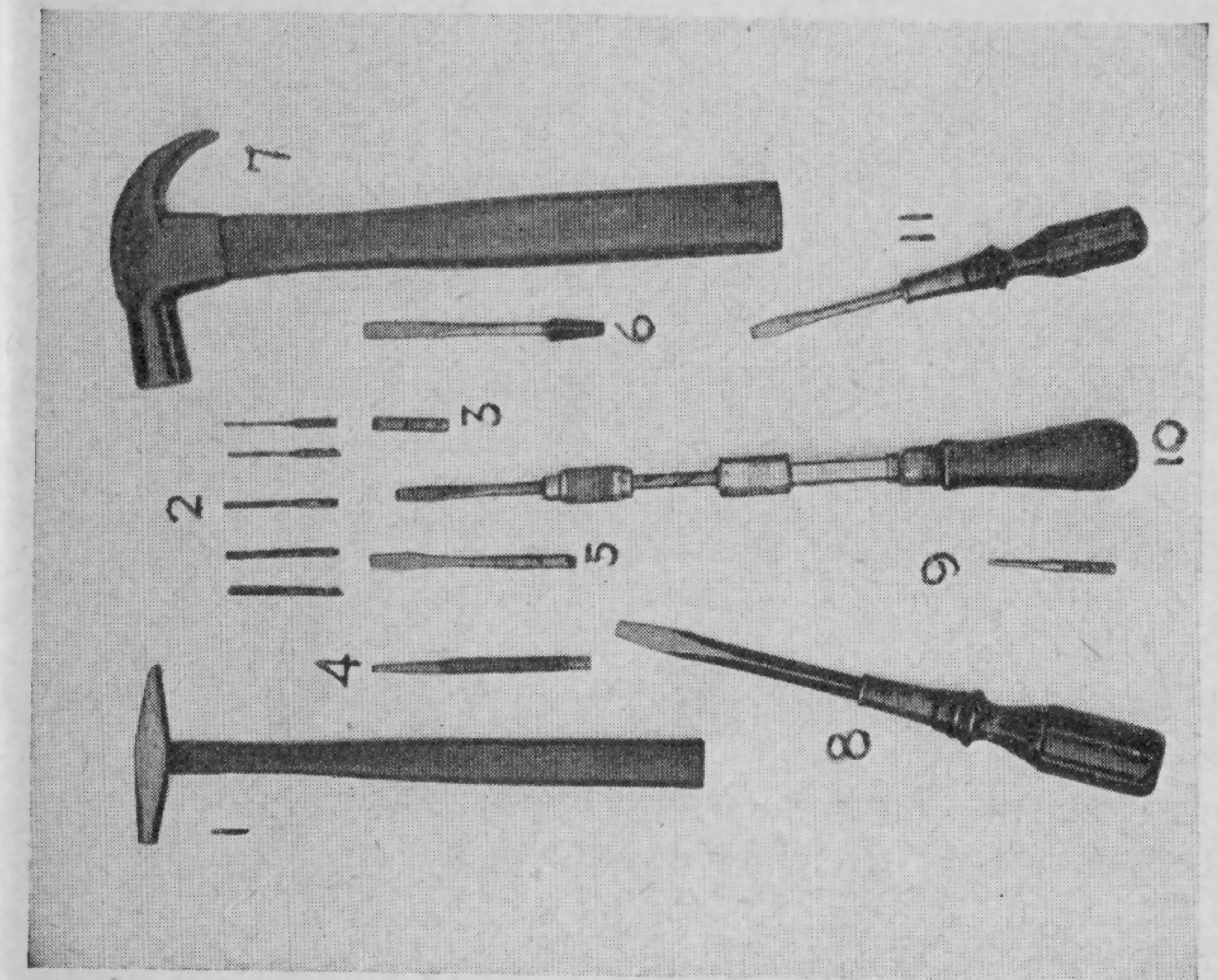
A CORNER OF A SMALL HOME WORKSHOP

Most of the tools are in sight and within easy reach of the bench. The doors in the lower part of the bench were utilized from an abandoned piece of walnut furniture.



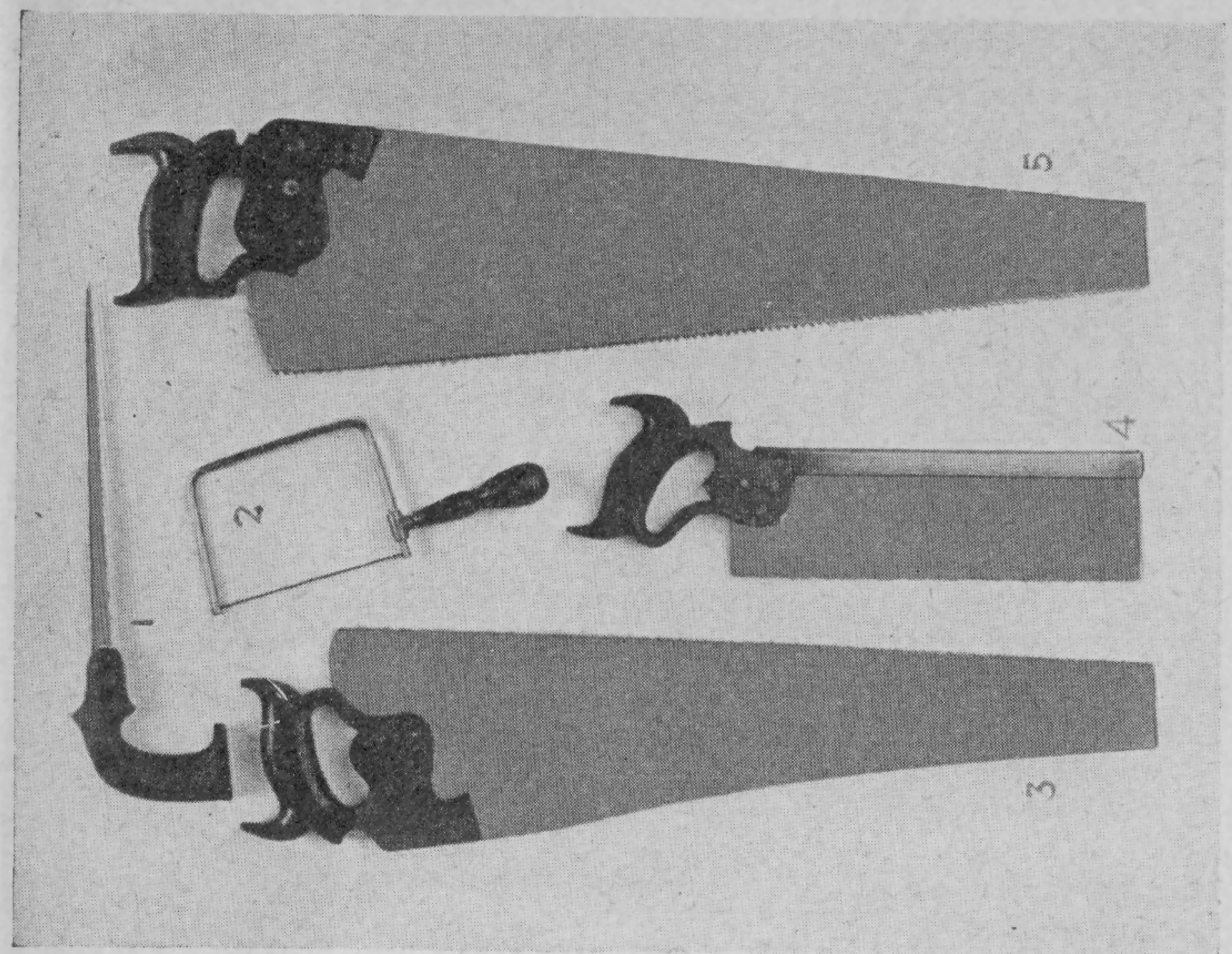
TOOLS FOR MARKING, TESTING, AND MEASURING

(1) Steel straightedge upon which is clamped a spirit level; (2) adjustable miter box with back saw; (3) adjustable bevel; (4) extension rule; (5) marking gauge; (6) marking awl; (7) square gauge; (8) try-square; (9) steel square.



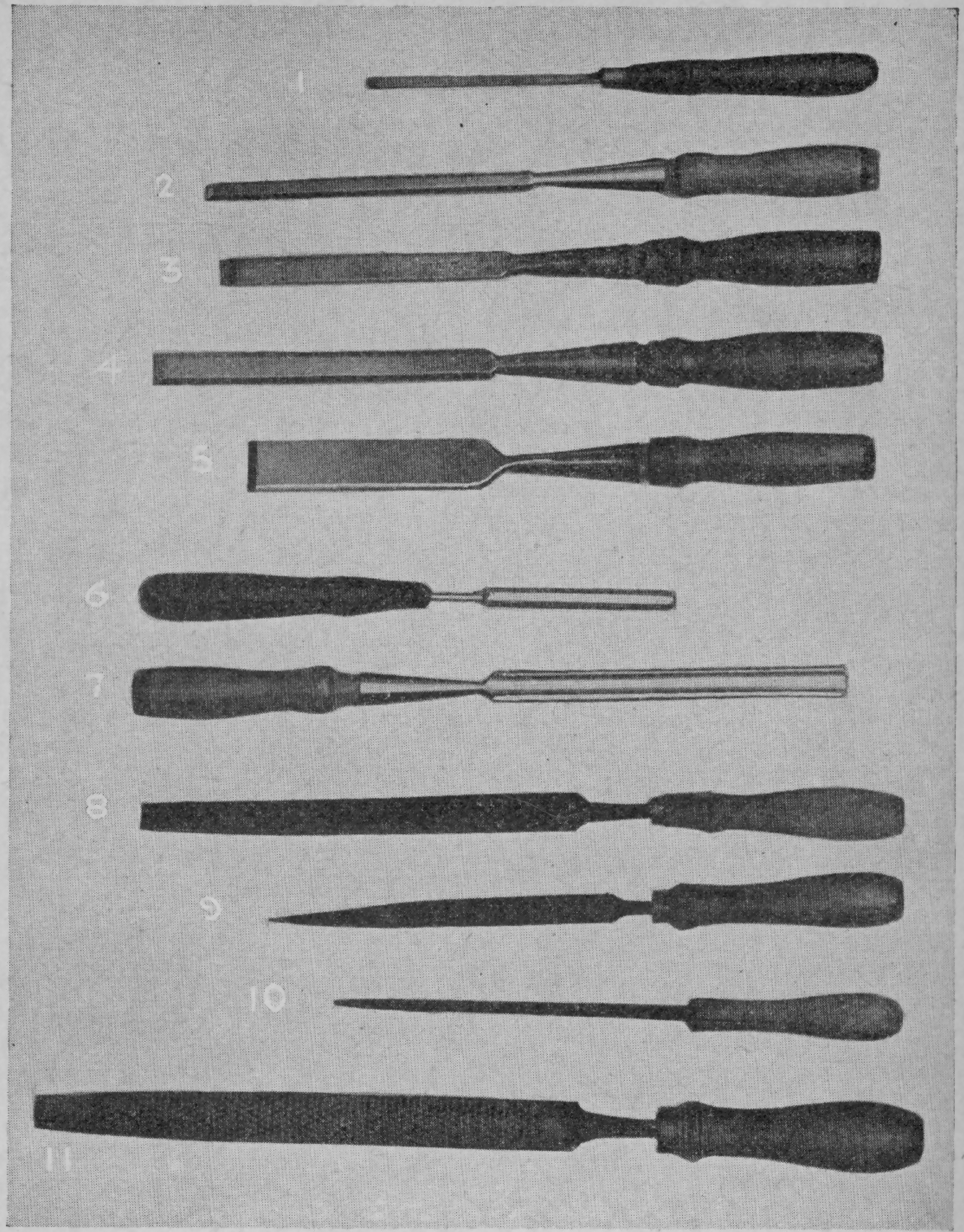
DRIVING TOOLS

(1) Riveting hammer (for driving brads and tacks); (2) drill points for use with chuck (3) in spiral-ratchet screwdriver; (4) nail set; (5) screwdriver bit for spiral-ratchet driver; (6) screwdriver bit for use in brace; (7) adze-eye hammer; (8) 10-inch screwdriver; (9) small screwdriver; (10) spiral-ratchet screwdriver; (11) 7-inch screwdriver.



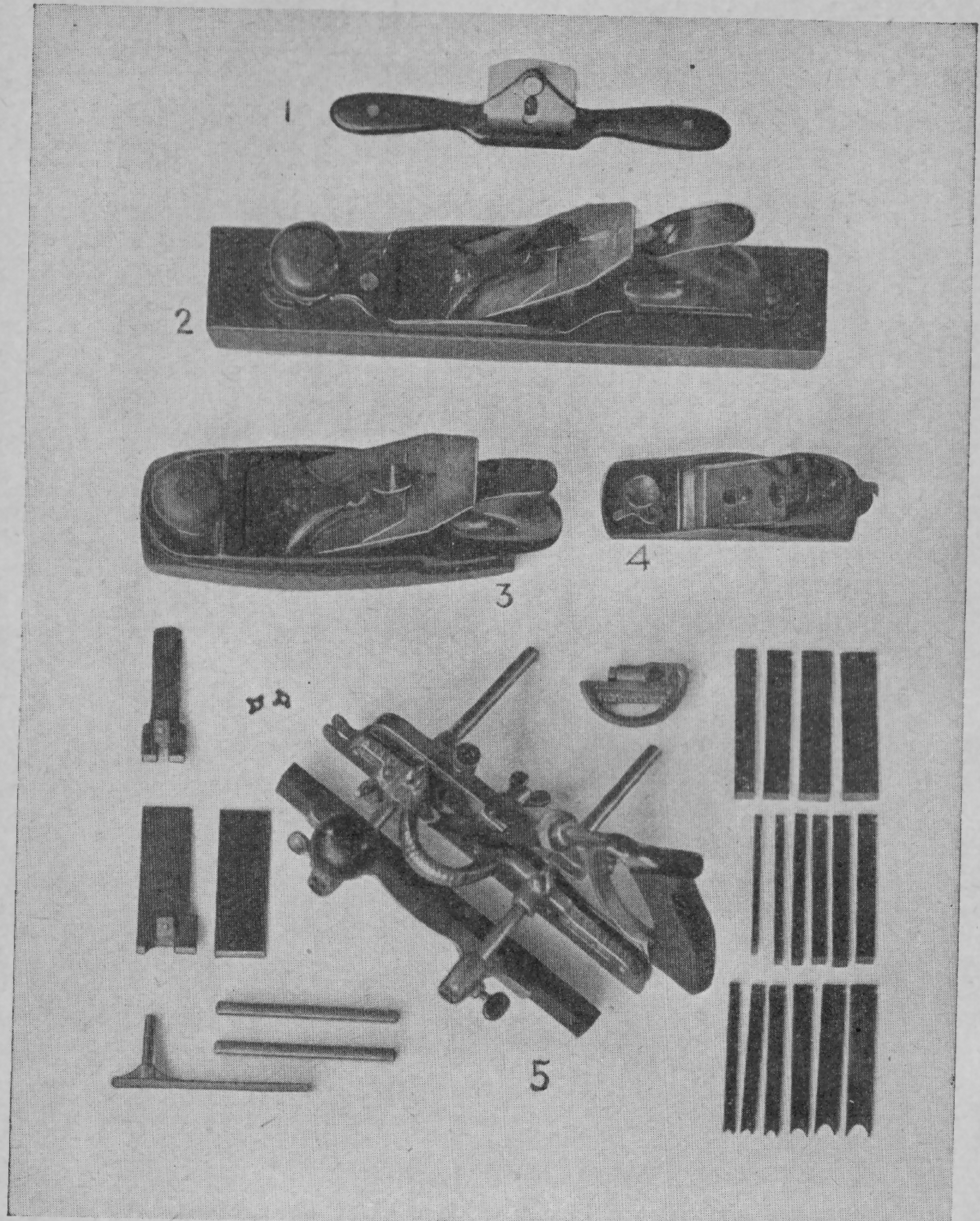
THE MORE COMMONLY USED SAWS

(1) 10-inch compass saw; (2) coping saw, with detachable blade; (3) 22-inch skew-back crosscut saw; (4) 12-inch back saw; (5) 24-inch straight-back ripsaw.



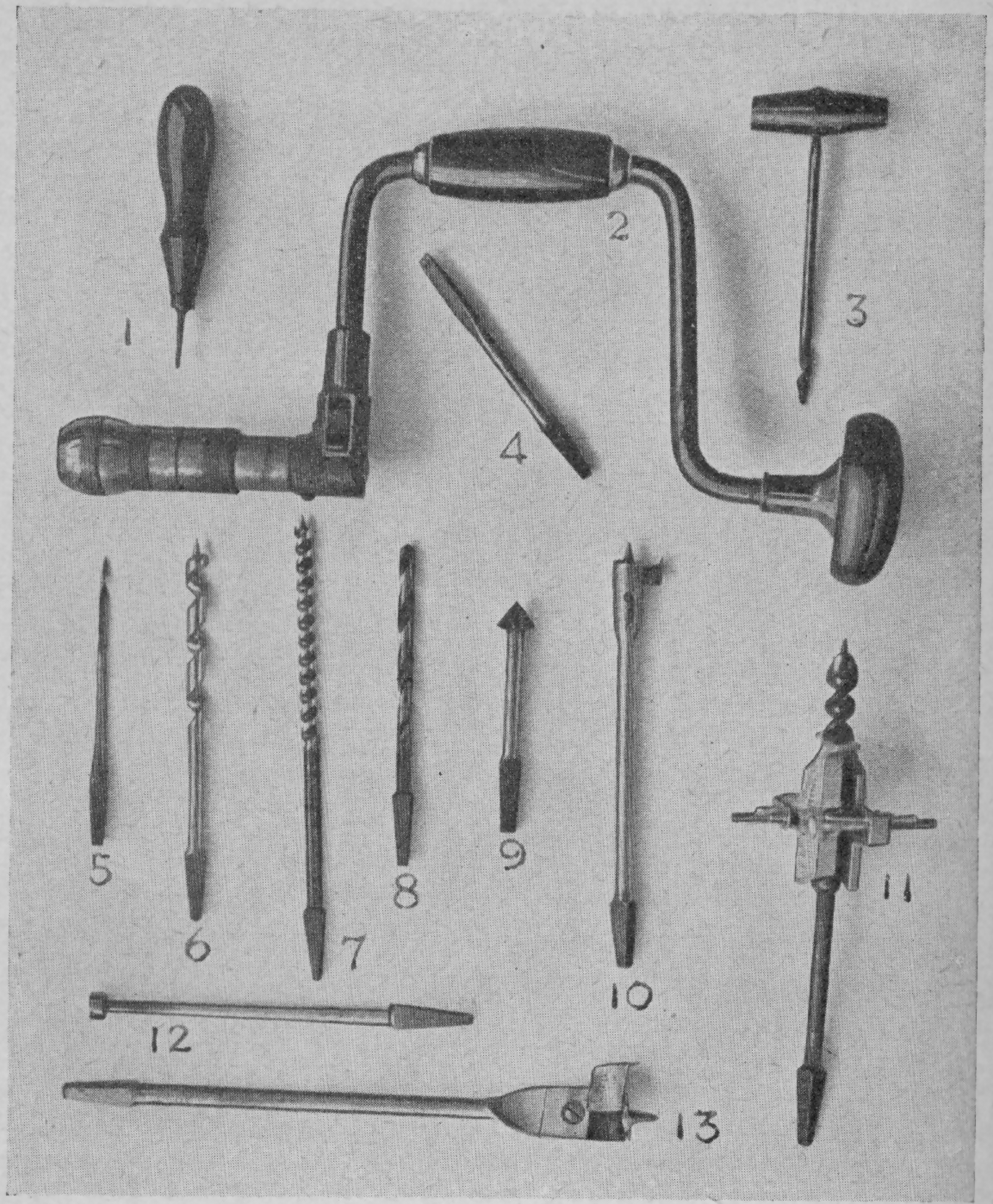
CHISELS, GOUGES, AND FILES

(1) $\frac{1}{4}$-inch tang firmer chisel; (2) $\frac{3}{8}$-inch socket chisel with beveled edge; (3) $\frac{1}{2}$-inch socket firmer chisel; (4) $\frac{5}{8}$-inch socket chisel with beveled edge; (5) 1-inch socket firmer chisel; (6) $\frac{1}{4}$-inch tang gouge; (7) $\frac{1}{2}$-inch socket gouge; (8) 8-inch flat bastard-cut file; (9) 6-inch warding bastard-cut file (for filing keys); (10) double-end triangular saw file; (11) 10-inch cabinet rasp (convex on one face, flat on other).



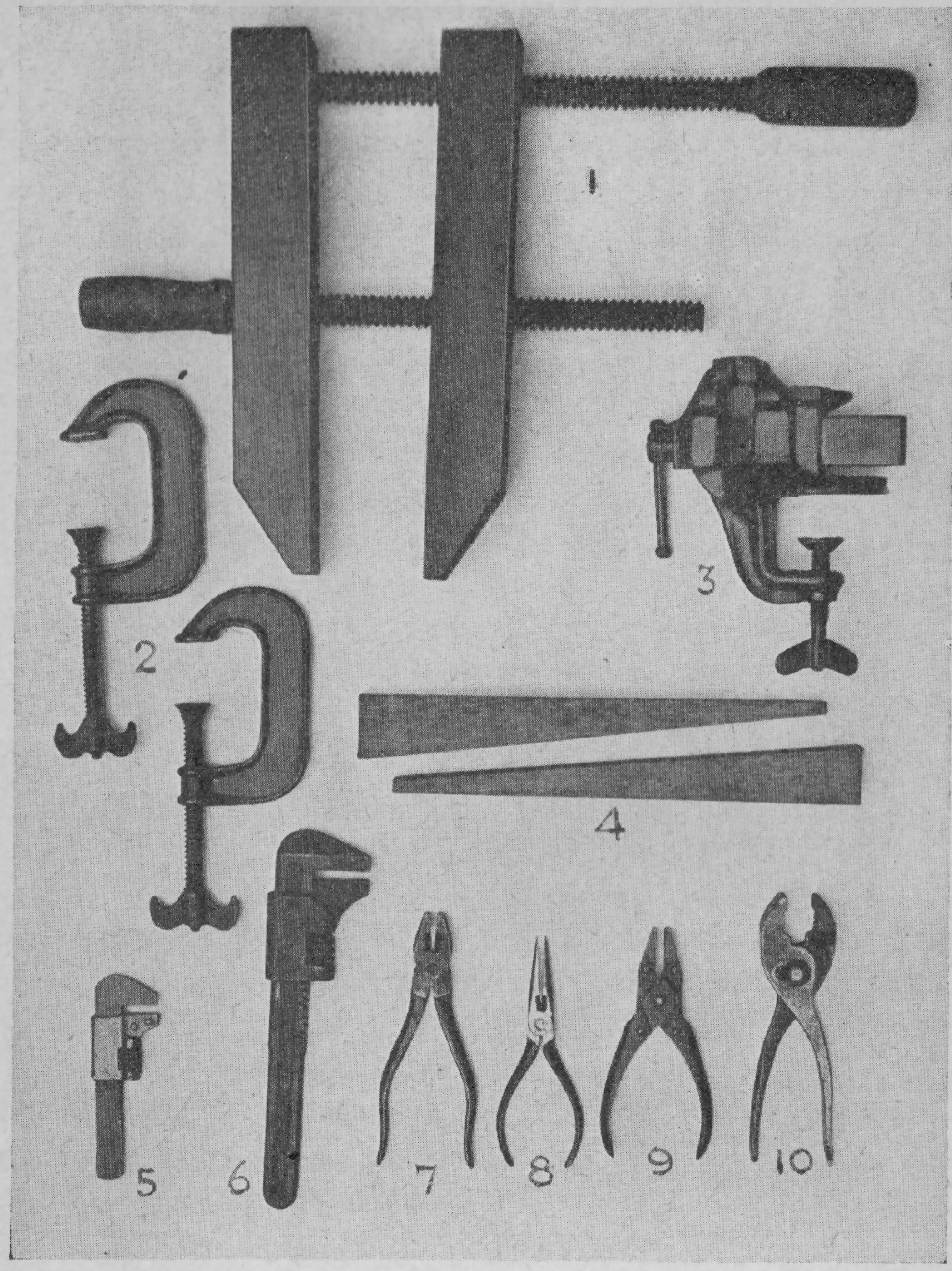
SOME MEMBERS OF THE PLANE FAMILY

(1) Spokeshave; (2) jack plane; (3) smoothing plane; (4) block plane; (5) combination plane with fence, various cutting bits, and other parts.



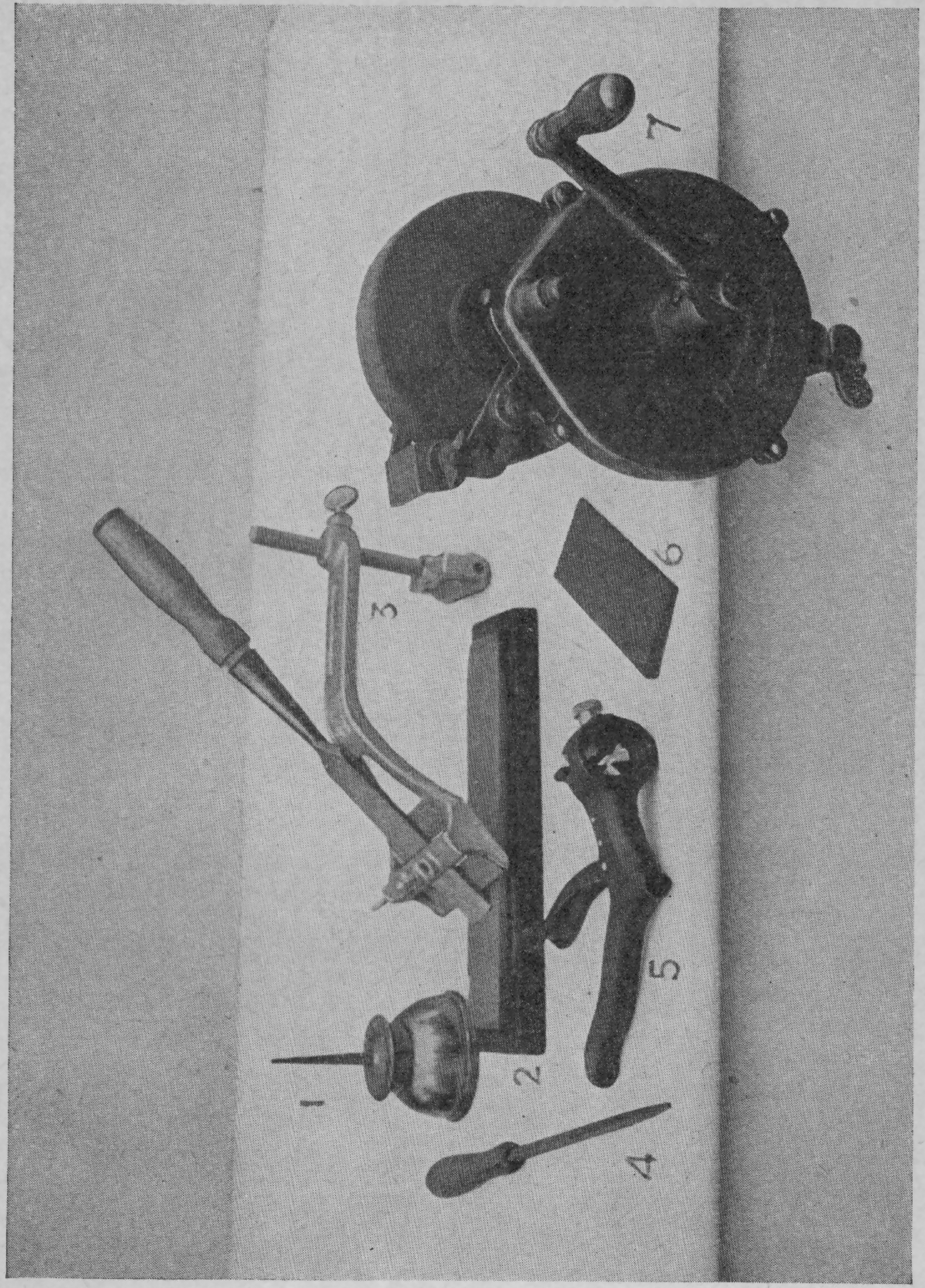
BORING TOOLS

(1) Brad awl; (2) ratchet brace; (3) gimlet; (4) screwdriver bit for use in brace; (5) gimlet bit for brace; (6, 7) auger bits; (8) twist bit; (9) rose bit for countersinking; (10) $\frac{1}{2}$-inch to $1\frac{1}{2}$-inches expansion bit (two cutters); (11) bit stop on auger bit; (12) Forstner bit; (13) $\frac{7}{8}$-inch to 3-inches expansion bit (two cutters).



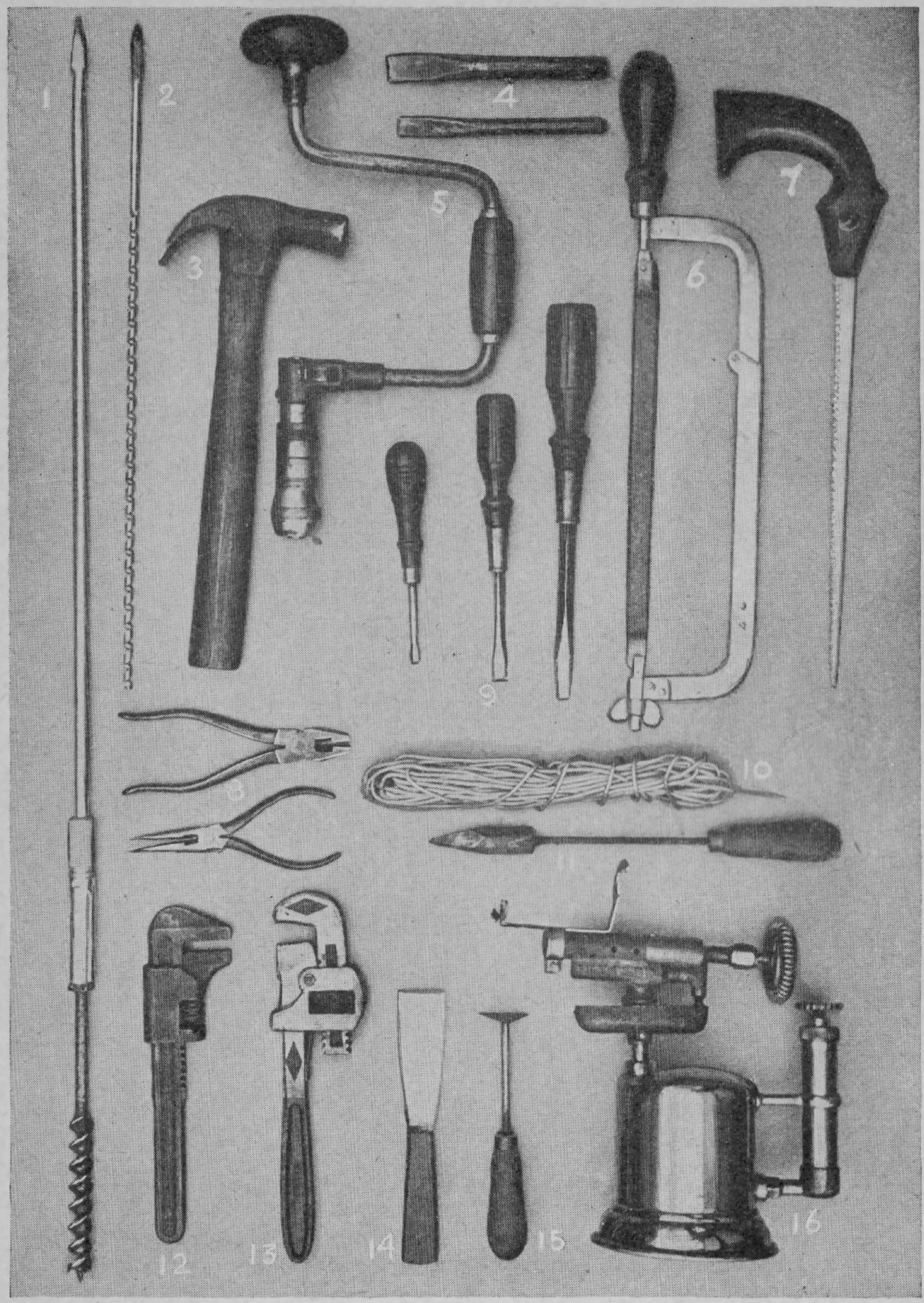
CRAMPING AND HOLDING TOOLS

(1) Hand screw; (2) pair of G-clamps; (3) small vise; (4) pair of folding wedges; (5) small wrench; (6) automobile wrench; (7) side-cutting pliers; (8) long "needle-nose" side-cutting pliers; (9) parallel-jaw pliers; (10) slip-joint automobile pliers.



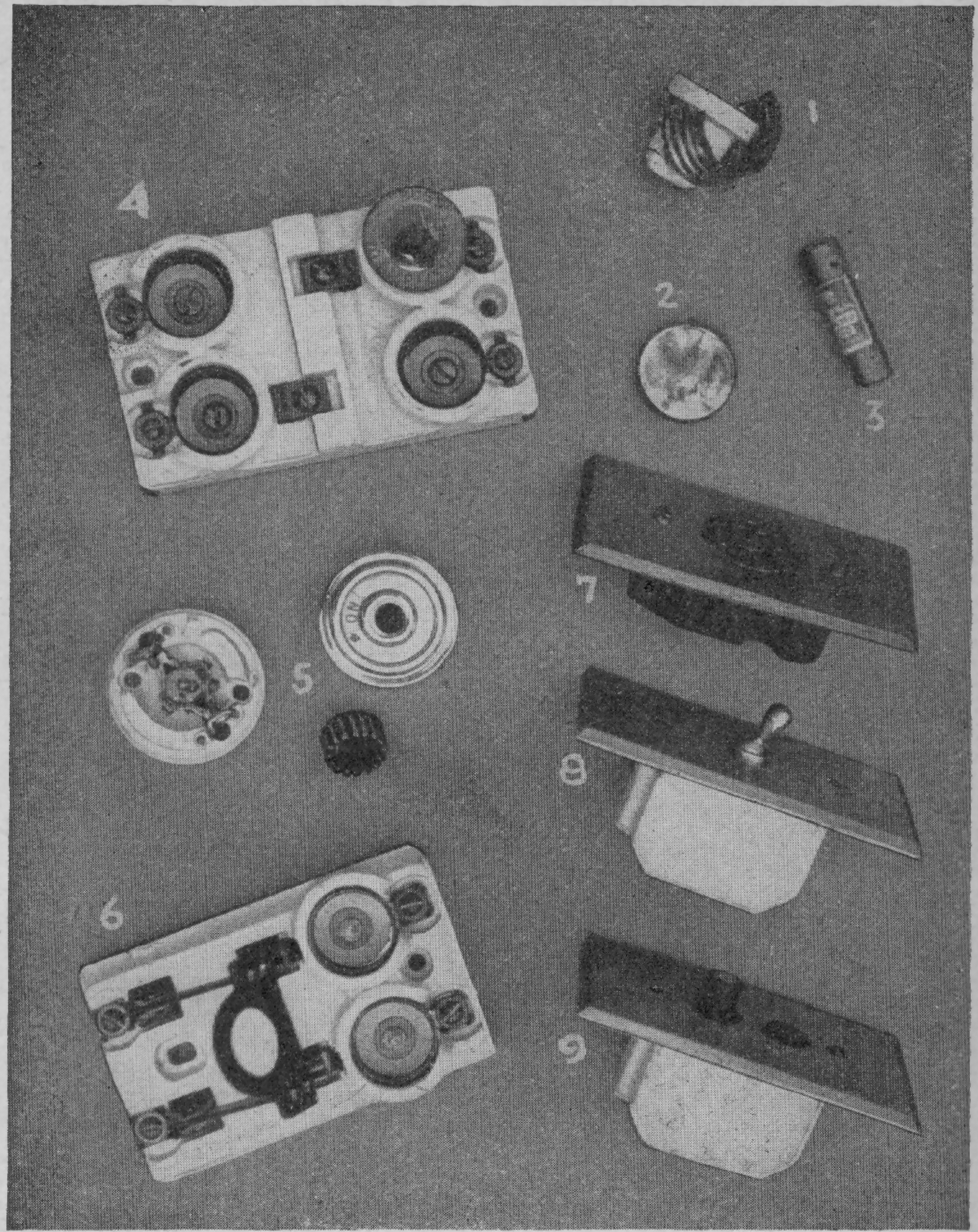
SHARPENING TOOLS

(1) Oil can; (2) oilstone; (3) grinder guide with chisel in place; (4) saw file; (5) saw set; (6) oilstone slip with round edge; (7) high-gear carborundum tool grinder.



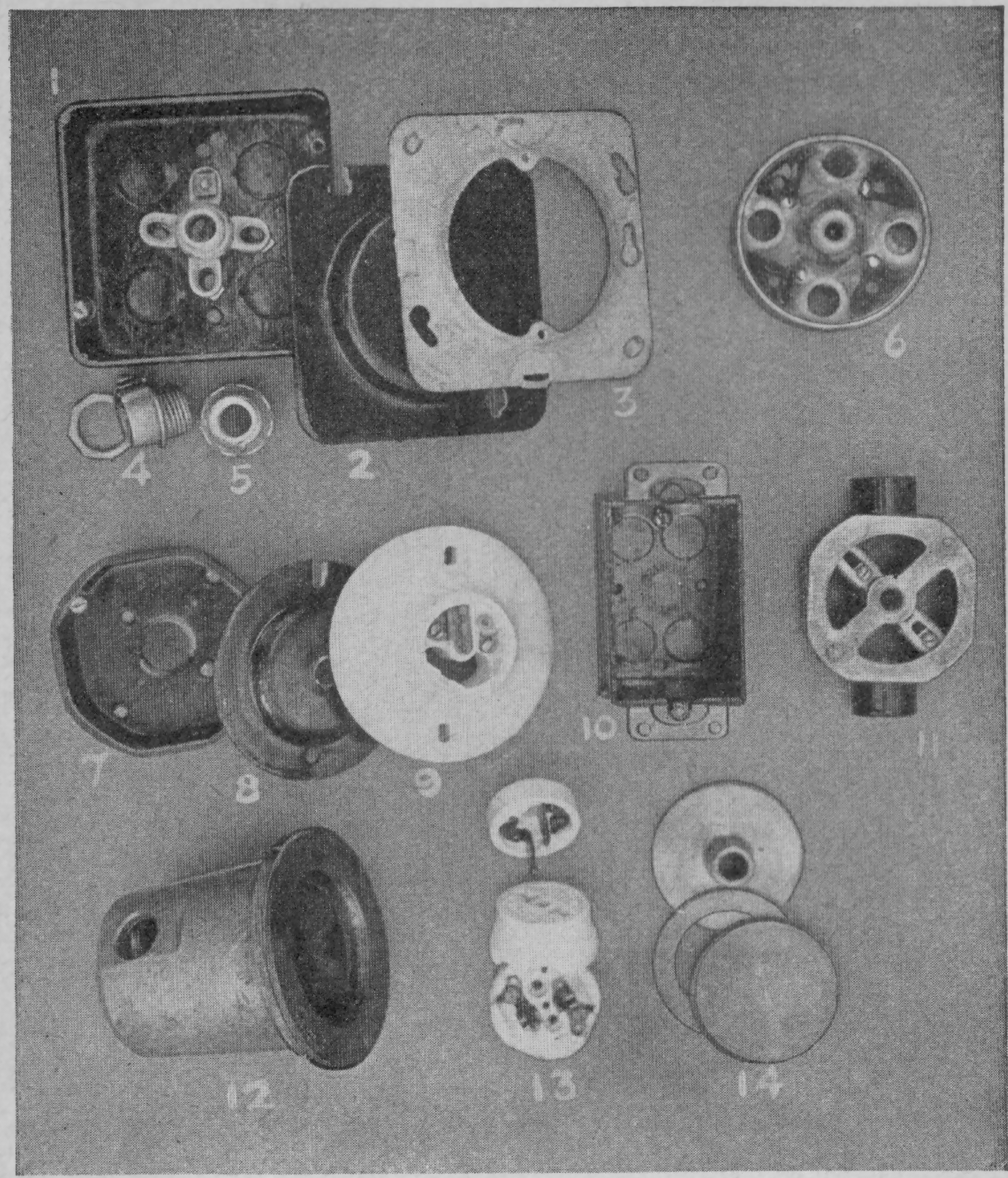
ELECTRICIAN'S TOOLS

(1) $\frac{5}{8}$-inch auger bit in an extension rod; (2) $\frac{1}{4}$-inch ship auger; (3) adze-eye hammer; (4) two sizes of cold chisels; (5) ratchet brace; (6) adjustable hack saw; (7) compass saw; (8) side-cutting pliers; (9) three sizes of screw-drivers; (10) wire solder; (11) soldering iron; (12) automobile wrench; (13) Stillson wrench; (14) putty knife; (15) triangular-bladed scraper, used in soldering; (16) gasoline blowtorch, pint size.



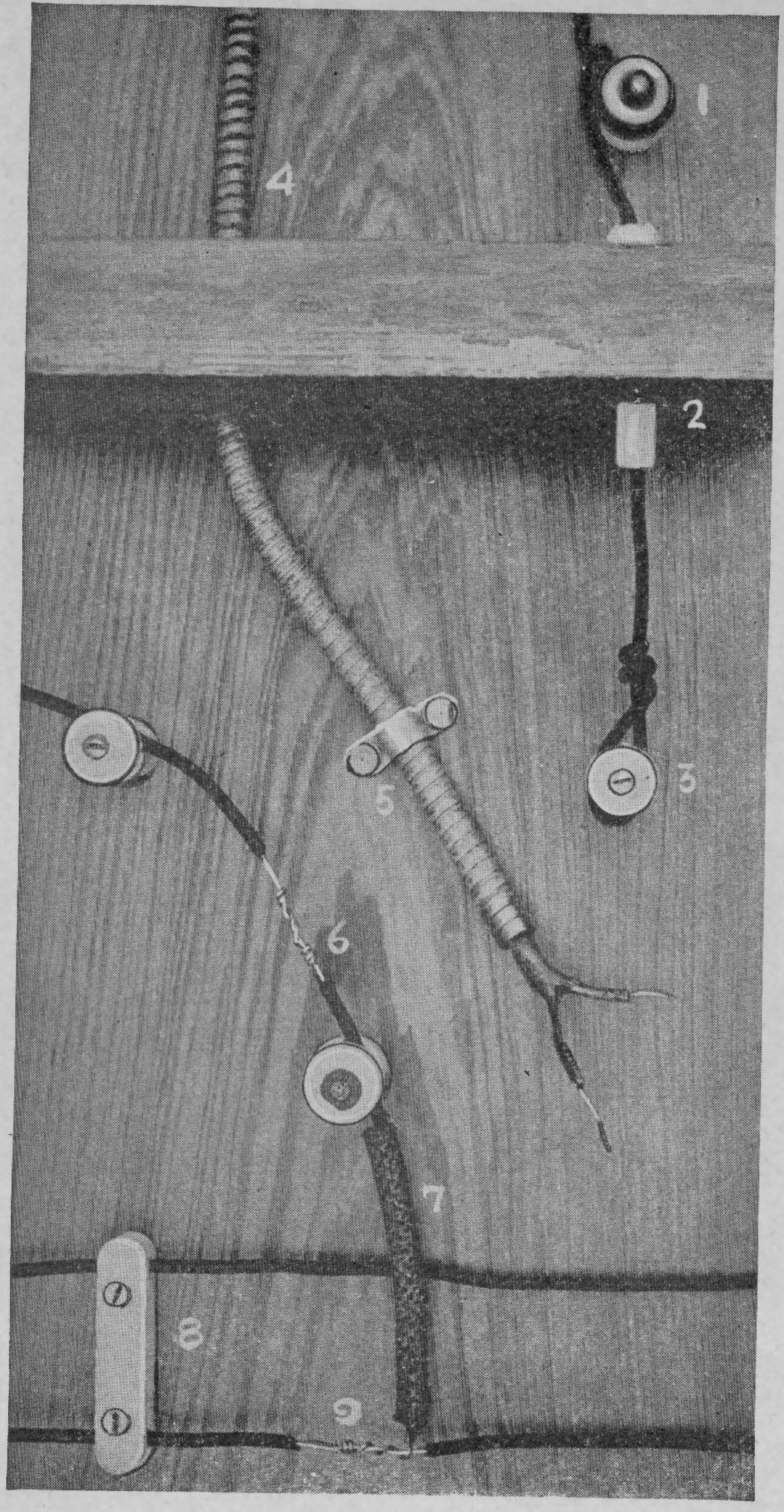
FUSES AND SWITCHES

(1) Fuse plug with collar broken away; (2) cap with mica window, for fuse plug; (3) cartridge fuse; (4) two-wire double branch block with integral fuse-plug sockets; (5) snap switch with button and cap removed; (6) double knife switch with integral fuse-plug sockets; (7) flush receptacle; (8) toggle flush switch; (9) flush switch.



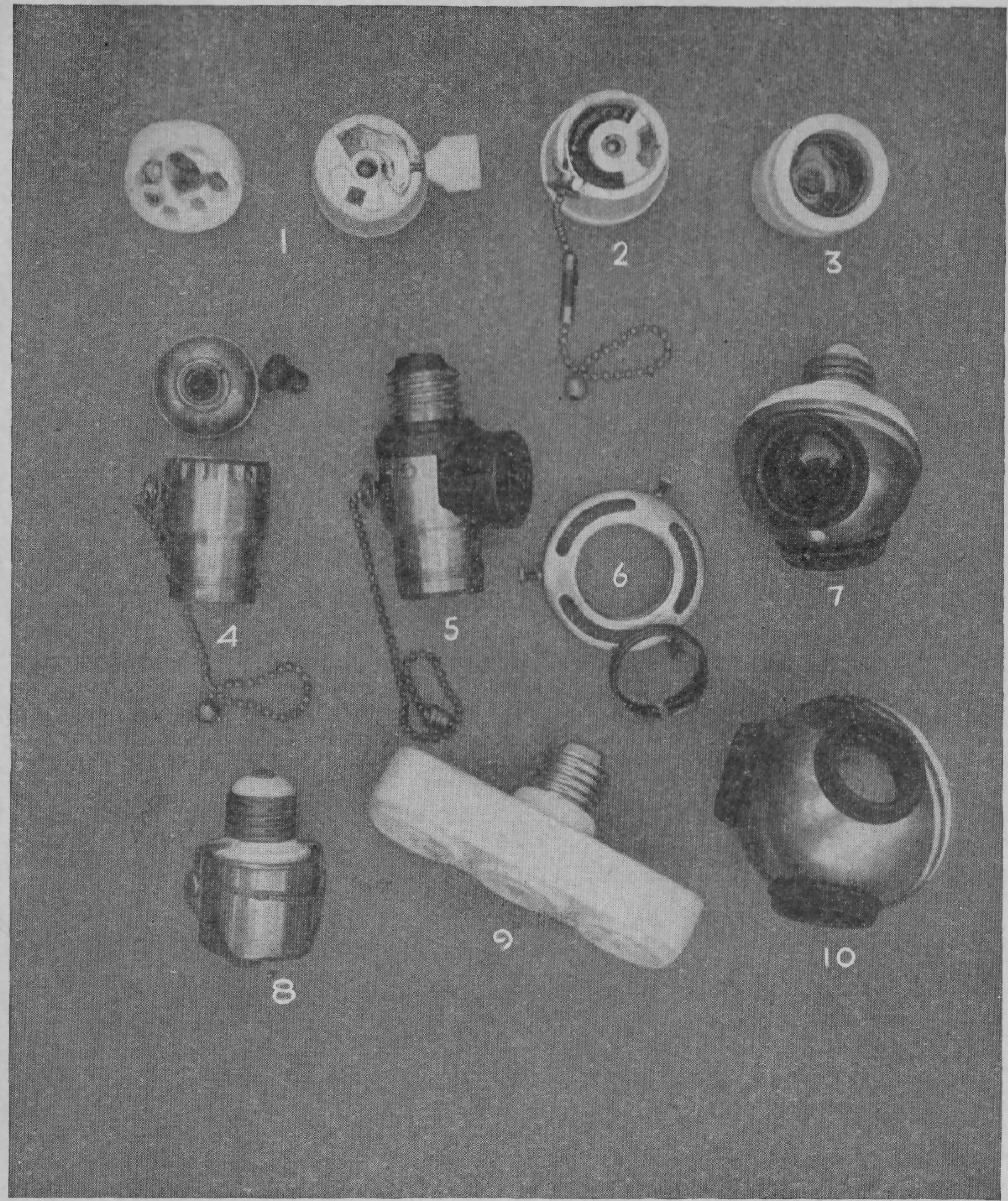
ELECTRIC-WIRING MATERIALS

(1) Outlet box for rigid conduit with fixture stud; (2) blank cover for outlet box when used as junction box; (3) outlet cover for same; (4) bushing and lock nut for use with armored cable; (5) porcelain bushing for use with knob-and-tube work; (6) outlet box for armored cable with fasteners attached; (7) 3-inch outlet box; (8) bushed cover for such box; (9) porcelain receptacle cover for it; (10) switch or receptacle outlet box for armored cable (the requisite holes can be punched out of the back); (11) condulet with spanner for switch or receptacle (for armored cable wiring); (12) brass floor receptacle; (13) porcelain interior fittings for this; (14) bushed top, gasket, and screw cover for it.



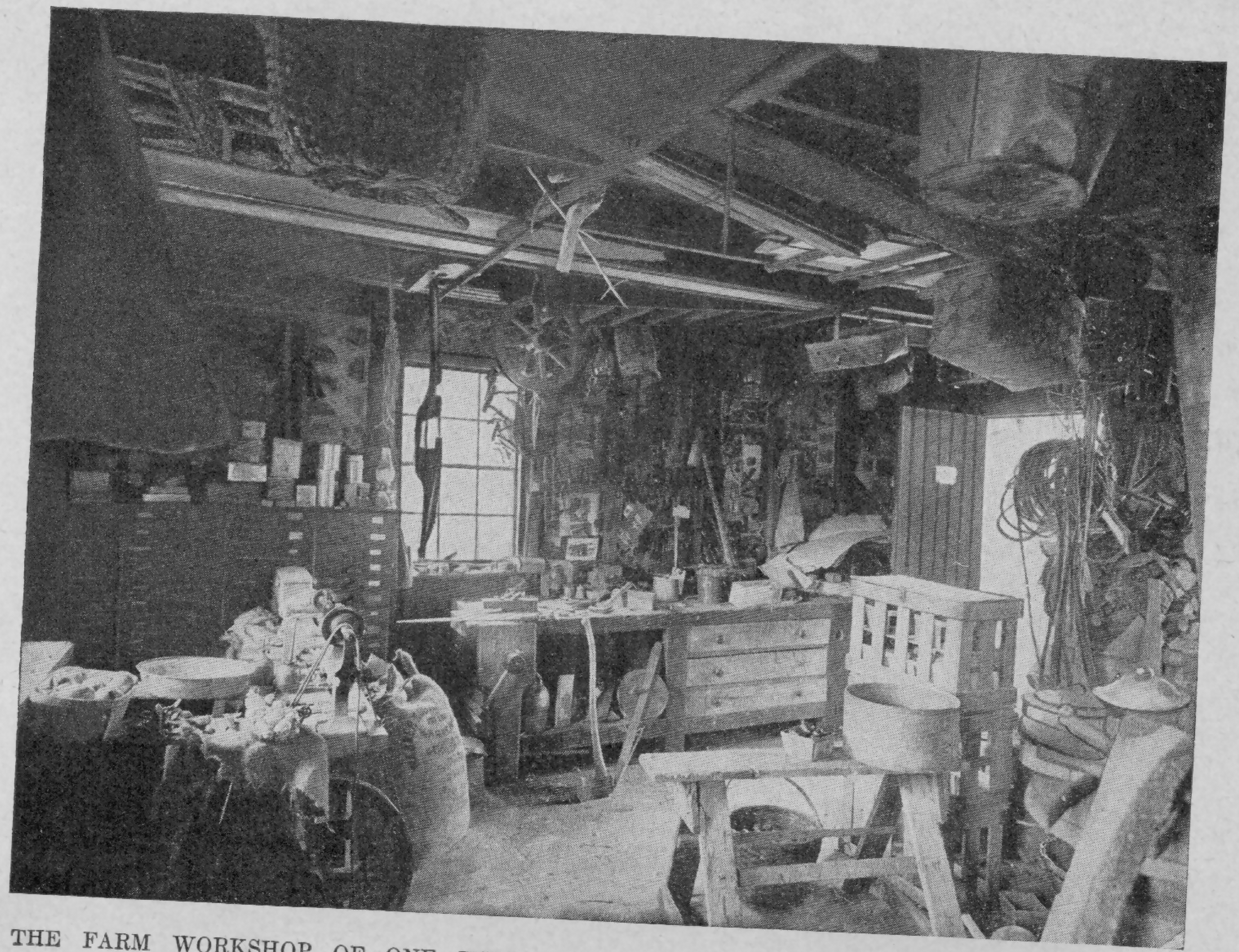
This is arranged to show: (1) Porcelain knob held with nail and leather washer, and the half-hitch of insulated electric light wire; (2) porcelain tube protecting wire through a floor joist; (3) a "dead end" of wire on a split knob; (4) armored cable (passes through joist in a $\frac{5}{8}$-inch hole), showing at its end the brass ferrule to protect the insulated wires inside; (5) strap used to secure cable; (6) a splice, to be soldered and wrapped with insulation; (7) a piece of loom at a crossing; (8) porcelain cleat; (9) a tap, to be soldered and wrapped.

A SPECIALLY WIRED PANEL



ELECTRICAL SOCKETS

(1) The two parts of a porcelain socket with key (the part at left, into which the wires are connected, is common also to the two following fittings); (2) the switch portion of a porcelain socket fitted with chain pull in place of key; (3) portion of a keyless porcelain socket; (4) brass chain-pull socket, with cap and hard-rubber bushing detached; (5) chain-pull screw socket with plug receptacle; (6) shade holder and its threaded bushing for brass socket; (7) double-outlet screw socket (to put two lights in the place of one); (8) dimmer screw socket; (9) triple-plug receptacle socket screw; (10) triple-outlet screw socket.



THE FARM WORKSHOP OF ONE WHO RETAINS A WORKING KNOWLEDGE OF ALL THE COMMON CRAFTS, SUCH AS MARKED THE EARLY PIONEERS IN AMERICA